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The scientific publications of the National Museum include two series, known, respectively, as *Proceedings* and *Bulletin*.

The *Proceedings*, begun in 1878, is intended primarily as a medium for the publication of original papers, based on the collections of the National Museum, that set forth newly acquired facts in biology, anthropology, and geology, with descriptions of new forms and revisions of limited groups. Copies of each paper, in pamphlet form, are distributed as published to libraries and scientific organizations and to specialists and others interested in the different subjects. The dates at which these separate papers are published are recorded in the table of contents of each of the volumes.

The present volume is the sixty-sixth of this series.

The *Bulletin*, the first of which was issued in 1875, consists of a series of separate publications comprising monographs of large zoological groups and other general systematic treatises (occasionally in several volumes), faunal works, reports of expeditions, catalogues of type-specimens, special collections, and other material of similar nature. The majority of the volumes are octavo in size, but a quarto size has been adopted in a few instances in which large plates were regarded as indispensable. In the *Bulletin* series appear volumes under the heading *Contributions from the United States National Herbarium*, in octavo form, published by the National Museum since 1902, which contain papers relating to the botanical collections of the Museum.

ALEXANDER WETMORE,
Assistant Secretary, Smithsonian Institution.

WASHINGTON, D. C., *January 26, 1926.*

TABLE OF CONTENTS

Article

ALDRICH, J. M. New diptera or two-winged flies in the United States National Museum. No. 2555, pp. 1–36. January 24, 1925 [1] 18

New genera: *Phobema, Balioglutum.*

New species: *Pholeomyia expansa, Chlorops kuwanae, Anastrepha schausi, A. barnesi, A. cordata, A. obscura, A. ornata, Phobema atrox, Lonchaea hirtithorax, Mesembrina magnifica, Balioglutum illingworthi. Mesembrinella spicata, M. uniseta, M. semiflava, M. flavicrura, Microcalliphora flavifrons, Notochaeta comata, N. townsendi, N. angusta, Sarcophaga placida, S. morosa, S. subaenescens, Atacta crassiceps, A. argentifrons, Masicera arator, Dexia ventralis.*

BARTSCH, PAUL. New mollusks from Santa Elena Bay, Ecuador. No. 2551, pp. 1–9. October 17, 1924 [1] 14

New species: *Pyramidella (Longchaeus) elenensis, Turbonilla (Chemnitzia) theone, T. (C.) oenoa, T. (Turbonilla) axeli, T. (Strioturbonilla) evagone, T. (S.) nychia, T. (S.) thyne, T. (Pyrgiscus) melea, T. (P.) evadna, T. (Bartschella) semela, Odostomia (Chrysallida) olssoni, O. (C.) melitta, Melanella (Melanella) olssoni, M. (Balcis) elenensis.*

BERRY, EDWARD W. A Pleistocene flora from the Island of Trinidad. No. 2558, pp. 1–9. May 23, 1925 [1] 21

New species: *Clusia fossilia, Mimusops preduplicata, Phyllites oropouchensis.*

CHANDLER, ASA C. Some parasitic round worms of the rabbit with descriptions of two new species. No. 2553, pp. 1–6. November 3, 1924 [1] 16

New species: *Nematodirus leporis.*

COCHRAN, DORIS M. Notes on the herpetological collections made by Dr. W. L. Abbott on the Island of Haiti. No. 2543, pp. 1–15. October 25, 1924 [1] 6

COCKERELL, T. D. A. Plant and insect fossils from the Green River Eocene of Colorado. No. 2556, pp. 1–13. February 16, 1925 [1] 19

New genera: *Alsinites, Eoliarus.*

New species: *Lejeunea eophila, Populus wilmattae, Bumelia coloradensis, Dalbergia knowltoni, Amorpha utensis, Clethra (?) lepidioides, Potentilla (?) byrami, Alsinites revelatus, Lomatia obtusiuscula, Banksites lineatulus, Liquidambar callarche, Cardiophorus exhumatus, Eoliarus quadristictus, Thamnotettix packardi, Cyttaromyia obdurescens.*

[1] Date of publication.

Article

COTTON, RICHARD T. A contribution toward the classification of the weevil larvae of the subfamily Calendrinae occurring in North America. No. 2542, pp. 1–11. October 11, 1924 [1] ... 5

CUSHMAN, JOSEPH A. A new genus of Eocene foraminifera, No. 2567, pp. 1–4. January 23, 1925 [1] ... 30

New genus: *Hantkenina*
New species: *Hantkenina brevispina, H. longispina, H. mexicana, H. alabamensis.*

DALL, WILLIAM HEALEY. Illustrations of unfigured types of shells in the collection of the United States National Museum. No. 2554, pp. 1–41. September 22, 1925 [1] ... 17

New species: *Ancistrolepis decora, A. okhotensis, Antiplanes yessoensis, Cirsotrema plexis, Cocculina rhyssa, Coralliophila spinosa, Cuspidaria trosaetes, Emarginula choristes, Euspira bahamensis, Murex (Pteropurpura) esychus, Suavodrillia sagamiana, Turbo asteriola, Turcicula japonica, Turricula (Surcula) hondoana, Volutopsius minor, Yoldia (Cnesterium) excavata, Y. (C.) johanni.*
New subgenus: *Orectospira.*

FISHER, WARREN S. Buprestid beetles collected by the Mulford Biological Exploration in Bolivia, No. 2568, pp. 1–46. February 13, 1925 [1] ... 31

New species: *Chrysobothris rogaguaensis, C. beniensis, C. cuprifrons, Actenodes manni, Autarchontes lopezi, Agrilus boliviensis, A. cavinas, A. takana, A. tumupasaensis, A. gorai, A. beniensis, A. manni, Paragrilus purpureus P. opacipennis, P. holomelas P. pulchellus, Pachyschelus cavinas, P. nudus, P. nigriventris, P. beniensis, Brachys takana, B. mositana, Taphrocerus parvus, Leiopleura gorai, L. boliviana, Callimicra acuminata, C. festiva, C. cyanoptera, C. viridifrons.*

GRAYBILL, H. W. A new species of round worm of the genus Trichostrongylus from the rabbit. No. 2548, pp. 1–3. October 8, 1924 [1] ... 11

New species: *Trichostrongylus affinis.*

GREENE, CHARLES T. The puparia and larvae of Sarcophagid flies, No. 2566, pp. 1–26. February 10, 1925 [1] ... 29

HAY, OLIVER P. A further and detailed description of the type of Elephas roosevelti Hay and descriptions of three referred specimens, No. 2571, pp. 1–6. May 22, 1925 [1] ... 34

——— On remains of mastodons found in Texas, Anancus brazosius and Gomphotherium cimarronis, No. 2572, pp. 1–15. April 25, 1925 [1] ... 35

[1] Date of publication.

Article

JORDAN, ERIC KNIGHT. Notes on the fishes of Hawaii with descriptions of six new species. No. 2570. pp. 1–43. September 22, 1925 [1] ---------------------------------- 33

New genera: *Leihala, Opua.*

New species: *Lepidapolis atrorubens, Scaridea farrandi, Scarus kraussi, S. galena, Opua nephodes, Cantherines verecundus.*

JUDAY, CHANCEY. Senecella calanoides, a recently described fresh-water copepod. No. 2541, pp. 1–6. May 23, 1925 [1]- 4

KELLOGG, REMINGTON. A fossil physeteroid cetacean from Santa Barbara County, California, No. 2564, pp. 1–8. February 28, 1925 [1] ---------------------------------- 27

New species: *Ontocetus oxymycterus.*

——— On the occurrence of remains of fossil porpoises of the genus Eurhinodelphis in North America, No. 2563, pp. 1–40. May 23, 1925 [1] ---------------------------------- 26

New species: *Eurhinodelphis bossi.*

KIRK, EDWIN. Harpidium, a new pentameroid brachiopod genus from southeastern Alaska, No. 2569, pp. 1–7. April 11, 1925 [1] ---------------------------------- 32

New species: *Harpidium insignis, H. rotundus, H. latus.*

LAIDLAW, FRANK FORTESCUE. Notes on oriental dragonflies of the genus Aciagrion. No. 2547, pp. 1–9. October 13, 1924 [1] ---------------------------------- 10

MALLOCH, J. R. Descriptions of Neotropical two-winged flies of the family Drosophilidae. No. 2540, pp. 1–11. October 13, 1924 [1] ---------------------------------- 3

New species: *Stegana interrupta, S. cristimana, S. nigrimana, Leucophenga brazilensis, Clastopteromyia floridana, C. triseta, Drosophila schildi, Scaptomyza nigripalpis, S. fuscinervis.*

MANSFIELD, WENDELL C. Miocene gastropods and scaphopods from Trinidad, British West Indies. No. 2559, pp. 1–65. September 18, 1925 [1] ---------------------------------- 22

New species: *Terebra (Strioterebra) trinitatensis, T. (S.) brassoënsis, Conus springvaleënsis, C. trinitatensis, C. manzanillaënsis, Turricula springvaleënsis, Turris brassoënsis, Drillia pennyi, D. tridadina, D. daditrina, D. propefusiformis, D. inniadda, D. nitrina, D. inadrina, D. manzanillaënsis, D. niaddrina, D. ritanida, Glyphostoma caronensis, G. (?), triniada, G. (?) addrina, Microdrillia trina, M. propetrina, Borsonia (Paraborsonia) brassoënsis, Cancellaria springvaleënsis, C. bullbrooki, Pseudoliva guppyi, Ancilla paralamellata, Marginella (Faba) bullbrooki, M. (F.) brassoënsis, M. guppyana, M. (Closia) nitrina, M. (Gibberula) trinitatensis, M. (Persicula) propeobesa, Phos trinitatensis, P.*

[1] Date of publication.

Article

bullbrooki, Alectrion brassoënsis, Metulella caronensis, Strombina walli, Typhis sawkinsi, Cypraea trinitatensis, Caecum properegulare, Petaloconchus alcimus, Turritella montserratensis, Amauropsis trinitatensis, Calliostoma attrina, C. rhombotum, Liotia machapoorieënsis, Teinostoma (Pseudorotella?) caronensis, Adeorbis guppyi, Cadulus caronensis.

New subspecies: *Conus multiliratus walli, Drillia consors bullbrooki, D. c. trinitatensis, D. pennyi acaria, Glyphostoma amicta rintriada, Ancilla caroniana springvalensis, Marginella solitaria montserratensis, Turritella gatunensis caronensis.*

MARSHALL, WILLIAM B. New species of mollusks of the genus Chilina. No. 2550, pp. 1–5. October 8, 1924 [1] 13

New species: *Chilina aurantia, C. castanea, C. flammulina, C. felipponei, C. oldroydae, C. olivacea.*

New subspecies: *Chilina parchappii minor.*

———. New Uruguayan mollusks of the genus Corbicula. No. 2552, pp. 1–12. November 3, 1924 [1] 15

New species: *Corbicula (Cyanocyclas) circularis, C. (C.) compacta, C. (C.) delicata, C. (C.) exquisita, C. (C.) felipponei, C. (C.) fortis, C. (C.) oleana, C. (C.) paysanduensis.*

MILLER, GERRIT S. Jr. A Pollack whale from Florida presented to the National Museum by the Miami Aquarium Association. No. 2546, pp. 1–15. December 11, 1924 [1] 9

———. A second instance of the development of rodent-like incisors in an Artiodactyl. No. 2545, pp. 1–4. October 13, 1924 [1] 8

———. Some hitherto unpublished photographs and measurements of the blue whale. No. 2544, pp. 1-4. November 3, 1924 [1] 7

REESIDE, JOHN B. Jr. A rare Cretaceous sea urchin, Scutellaster cretaceus Cragin. No. 2557, pp. 1–4. December 9, 1924 [1] 20

New genus: *Scutellaster.*

New species: *Scutellaster cretaceus.*

SCHWARTZ, BENJAMIN. A new proliferating larval tapeworm from a porcupine, No. 2561, pp. 1–4. December 26, 1924 [1]. 24

New species: *Taenia twitchelli.*

———. Parasitic nematodes from Tonkin, Indo-China, including a new species of Ascaridia. No. 2538, pp. 1–9. May 14, 1925 [1] 1

New species: *Ascaridia anseris.*

[1] Date of publication.

Article

SHANNON, EARL V. Mineralogy and petrography of Triassic limestone conglomerate metamorphosed by intrusive diabase at Leesburg, Virginia, No. 2565, pp. 1–31. May 22, 1925 [1] 28

———. The mineralogy and petrology of intrusive Triassic diabase at Goose Creek, Loudoun County, Virginia. No. 2539, pp. 1–86. December 13, 1924 [1] ---------------- 2

SMITH, FRANK. A new earthworm from Texas belonging to the genus Diplocardia. No. 2549, pp. 1–6. October 6, 1924 [1] 12

New variety: *Diplocardia keyesi texensis.*

STEJNEGER, LEONHARD. Chinese amphibians and reptiles in the United States National Museum. No. 2562, pp. 1–115. July 15, 1925 [1] ---------------- 25

VAN DUZEE, M. C. A revision of the North American species of the genus Argyra Macquart, two-winged flies of the family Dolichopodidae, No. 2560, pp. 1–43. May 5, 1925 [1] ---------------- 23

New species: *Argyra hirta, A. angustata, A. brevipes, A. barbipes, A. scutellaris, A. nigriventris, A. argentiventris, A. femoralis, A. bimaculata, A. velutina, A. splendida, A. thoracica, A. currani, A. nigricoxa, A. californica, A. sericata, A. albicoxa, A. setipes, A. flavipes, A. flavicornis, A. obscura, A. (Leucostola) johnsoni, A. (L.) involuta, A. (L.) flavicoxa, A. (L.) inaequalis, A. (L.) spina.*

[1] Date of publication.

80894—26——2

LIST OF ILLUSTRATIONS

PLATES

The mineralogy and petrology of intrusive Triassic diabase at Goose Creek, Loudoun County, Virginia

By Earl V. Shannon

	Facing page
1. Diabase pegmatite in diabase	86
2. Aplite, diabase, and diabase pegmatite	86
3. Diabase and diabase pegmatite cut by hornblendizing seam	86
4. Photomicrographs of diabase and diabase pegmatite	86
5. Photomicrographs of diabase pegmatite	86
6. Albitic pegmatite in diabase	86
7. Photomicrographs of albitic pegmatite	86
8. Augite blades in diabase pegmatite	86
9. Micropegmatite in aplite and albite pegmatite	86

Senecella calanoides, a recently described fresh-water copepod

By Chancey Juday

1. Female of *Senecella calanoides* — 6
2. Male and female of *Senecella calanoides* — 6
3. Male of *Senecella calanoides* — 6

A contribution toward the classification of the weevil larvae of the subfamily Calendrinae occurring in North America

By Richard T. Cotton

1. Details of *Cactophagus validus* (LeConte) — 12
2. Details of *Rhodobaenus tredecimpunctatus* (Illiger) — 12
3. Details of *Sitophilus granarius* (Linnaeus) — 12
4. Details of *Cosmopolites sordidus* Germar — 12
5. Details of *Metamasius sericeus* (Latreille) — 12
6. Details of *Calendra callosus* (Olivier) — 12
7. Details of *Rhynchophorus cruentatus* (Fabricius) — 12
8. Details of *Scyphophorus acupunctatus* (Gyllenhal) — 12
9. Details of the genus *Yuccaborus* LeConte — 12
10. Buccal characters of Calendrinae — 12

Some hitherto unpublished photographs and measurements of the blue whale

By Gerrit S. Miller, jr.

1. Blue whale: Dorsal aspect of skull — 4
2. Blue whale: Ventral aspect of skull — 4
3. Blue whale: Lateral aspect of skull — 4

Facing page

4. Blue whale: Anterior aspect of atlas 4
5. Blue whale: Anterior aspect of axis 4
6. Blue whale: Outer aspect of sternum 4
7. Blue whale: Outer aspect of right scapula 4
8. Blue whale: Inner aspect of left fore limb 4
9. Blue whale: Pelvic elements 4

A second instance of the development of rodent-like incisors in an Artiodactyl

By Gerrit S. Miller, jr.

1. Incisor teeth of *Vicunia* (1–9) and *Guanaco* (10–15) 4

A Pollack whale from Florida presented to the National Museum by the Miami Aquarium Association

By Gerrit S. Miller, jr.

1. Pollack whale: Skull from above 16
2. Pollack whale: Skull from below 16
3. Pollack whale: Skull from the side 16
4. Pollack whale: Oblique view of braincase 16
5. Pollack whale: Cervical vertebrae Nos. 1, 2, and 3 16
6. Pollack whale: Cervical vertebrae Nos. 4, 5, and 6 16
7. Pollack whale: Cervical vertebra No. 7 and dorsal vertebra No. 1 16
8. Pollack whale: Cervical vertebrae Nos. 4, 5, 6, and 7; dorsal vertebra No. 1 16
9. Pollack whale: Cervical vertebra No. 6 16
10. Pollack whale: Dorsal vertebra No. 1 16
11. Pollack whale: Cervical vertebra No. 6 and dorsal vertebra No. 1 16
12. Pollack whale: Dorsal vertebrae Nos. 2–14 and lumbar vertebrae Nos. 1–5 16
13. Pollack whale: Lumbar vertebrae Nos. 6–13 and caudal vertebrae Nos. 1–19 16
14. Pollack whale: Lumbar vertebra No. 1 and caudal vertebra No. 1 16
15. Pollack whale: Lumber vertebra No. 1 and caudal vertebra No. 1 16
16. Pollack whale: Right ribs 16
17. Pollack whale: Right scapula 16
18. Pollack whale: Sternum, stylohyal, and basihyal 16
19. Pollack whale: Jugal and forearm 16
20. Pollack whale: Bones of the hand 16
21. Pollack whale: Lacrimals and baleen plate from near middle of series 16
22. Pollack whale: Tympanic and periotic bones 16

Notes on oriental dragonflies of the genus Aciagrion

By Frank Fortescue Laidlaw

1. Details of dragonflies of the genus *Aciagrion* 10

A new species of round worm of the genus Trichostrongylus from the rabbit

By H. W. Graybill

1. *Trichostrongylus affinis*, new species 2

NEW SPECIES OF MOLLUSKS OF THE GENUS CHILINA

By William B. Marshall

Facing page

1. New mollusks of the genus *Chilina* 6

NEW MOLLUSKS FROM SANTA ELENA BAY, ECUADOR

By Paul Bartsch

1–2. New mollusks from Ecuador 10

NEW URUGUAYAN MOLLUSKS OF THE GENUS CORBICULA

By William B. Marshall

1–2. New Uruguayan Corbiculidae 12

SOME PARASITIC ROUNDS WORMS OF THE RABBIT WITH DESCRIPTIONS OF TWO NEW SPECIES

By Asa C. Chandler

1. *Trichostrongylus calcaratus* and *Nematodirus leporis* 6
2. *Obeliscus cuniculi* 6

ILLUSTRATIONS OF UNFIGURED TYPES OF SHELLS IN THE COLLECTION OF THE UNITED STATES NATIONAL MUSEUM

By William Healey Dall

1–11. Illustrations of types 42
12. *Sanguinolaria orcutti* Dall 42
13. Illustrations of types 42
14. *Chrysodomus eulimatus* Dall 42
15–16. *Acmaea digitalis* Eschscholtz 42
17–36. Illustrations of types 42

PLANT AND INSECT FOSSILS FROM THE GREEN RIVER EOCENE OF COLORADO

By T. D. A. Cockerell

1–2. Fossils from the Green River Eocene 14

A RARE CRETACEOUS SEA URCHIN SCUTELLASTER CRETACEUS CRAGIN

By John B. Reeside, jr.

1. *Scutellaster cretaceus* Cragin 4

A PLEISTOCENE FLORA FROM THE ISLAND OF TRINIDAD

By Edward W. Berry

1–4. Pleistocene flora from the island of Trinidad 10

MIOCENE GASTROPODS AND SCAPHOPODS FROM TRINIDAD, BRITISH WEST INDIES

By Wendell C. Mansfield

1–6. Miocene gastropods from Trinidad 66
7. Miocene gastropods and scaphopods from Trinidad 66
8–10. Miocene gastropods from Trinidad 66

A REVISION OF THE NORTH AMERICAN SPECIES OF THE GENUS ARGYRA MACQUART, TWO-WINGED FLIES OF THE FAMILY DOLICHOPODIDAE

By M. C. Van Duzee

Facing page

1. North American species of the genus *Argyra* 44

A NEW PROLIFERATING LARVAL TAPEWORM FROM A PORCUPINE

By Benjamin Schwartz

1. *Taenia twitchelli*, new species 4

ON THE OCCURRENCE OF REMAINS OF FOSSIL PORPOISES OF THE GENUS EURHINODELPHIS IN NORTH AMERICA

By Remington Kellogg

1. Dorsal and ventral views of type skull of *Eurhinodelphis bossi* 40
2. Lateral view of type skull of *Eurhinodelphis bossi* 40
3. Dorsal view of type mandible of *Eurhinodelphis bossi* 40
4. Posterior view of type skull of *Eurhinodelphis bossi* 40
5. Ventral view of a skull of *Eurhinodelphis bossi* 40
6. Views of scapula, cervical, and epiphysis of *Eurhinodelphis bossi* 40
7. Views of dorsal vertebrae of *Eurhinodelphis bossi* 40
8. Views of dorsal and lumbar vertebrae of *Eurhinodelphis bossi* 40
9. Views of dorsal and lumbar vertebrae of *Eurhinodelphis bossi* 40
10. Views of caudal vertebrae of *Eurhinodelphis bossi* 40
11. Lateral views of caudal vertebrae of *Eurhinodelphis bossi* 40
12. Views of caudal vertebrae and humerus of *Eurhinodelphis bossi* 40
13. Ventral views of caudal vertebrae of *Eurhinodelphis bossi* 40
14. Lateral views of ribs of *Eurhinodelphis bossi* 40
15. Dorsal and ventral views of a skull of *Eurhinodelphis bossi* 40
16. Views of two skulls of *Eurhinodelphis bossi* 40
17. Lateral view of a skull of *Eurhinodelphis bossi* 40

A FOSSIL PHYSETEROID CETACEAN FROM SANTA BARBARA COUNTY, CALIFORNIA

By Remington Kellogg

1. Views of rostrum and mandibles of *Ontocetus oxymycterus* 8
2. Views of rostrum and right mandible of *Ontocetus oxymycterus* 8

MINERALOGY AND PETROGRAPHY OF TRIASSIC LIMESTONE CONGLOMERATE METAMORPHOSED BY INTRUSIVE DIABASE AT LEESBURG, VIRGINIA

By Earl V. Shannon

1. Replacement of limestone conglomerate along fissure 32
2. Crust of datolite crystals 32
3. Anhydrite molds, calcite, datolite, and barite 32

THE PUPARIA AND LARVAE OF SARCOPHAGID FLIES

By Charles T. Greene

1–8. The puparia of Sarcophagid flies 26
9. The larvae of Sarcophagid flies 26

A NEW GENUS OF EOCENE FORAMINIFERA

By Joseph A. Cushman

Facing page

1. *Hantkenina alabamensis*, new species ---------- 4
2. Side views of various species of *Hantkenina* ---------- 4

HARPIDIUM, A NEW PENTAMEROID BRACHIOPOD GENUS FROM SOUTHEASTERN ALASKA

By Edwin Kirk

Page

1. *Harpidium insignis*, new species ---------- 6
2. *Harpidium latus*, *H. insignis*, and *H. rotundus* ---------- 7

NOTES ON THE FISHES OF HAWAII WITH DESCRIPTIONS OF SIX NEW SPECIES

By Eric Knight Jordan

1. *Leihala tritor;* Upper teeth of same; *Lepidaplois atrorubens; Scaridea farrandi* ---------- 44
2. *Scarus kraussi; Opua nephodes; Cantherines verecunda* ---------- 44

A FURTHER AND DETAILED DESCRIPTION OF THE TYPE OF ELEPHAS ROOSEVELTI HAY AND DESCRIPTIONS OF THREE REFERRED SPECIMENS

By Oliver P. Hay

1. Right upper third molar of *Elephas roosevelti* ---------- 6
2. Right lower third molar of *Elephas roosevelti* ---------- 6
3. Molars of *Elephas roosevelti* ---------- 6
4. Upper teeth and palate of *Elephas roosevelti* ---------- 6

ON REMAINS OF MASTODONS FOUND IN TEXAS, ANANCUS BRAZOSIUS AND GOMPHOTHERIUM CIMARRONIS

By Oliver P. Hay

1. Lower molar of *Anancus brazosius* ---------- 16
2. Lower jaw of *Anancus brazosius* ---------- 16
3. Teeth of *Anancus brazosius* and of *Gomphotherium cimarronis* ---------- 16
4. Teeth and tusks of *Gomphotherium cimarronis* ---------- 16

TEXT FIGURES

PARASITIC NEMATODES FROM TONKIN, INDO-CHINA, INCLUDING A NEW SPECIES OF ASCARIDIA

By Benjamin Schwartz

1. *Ascaridia anseris* (Tail of male): *a*, anus; *s*, sucker; *sp.*, spicules; *1l–6l*, first to sixth lateral papillae, respectively; *x*, accessory ventral papilla ---------- 5

THE MINERALOGY AND PETROLOGY OF INTRUSIVE TRIASSIC DIABASE AT GOOSE CREEK, LOUDOUN COUNTY, VIRGINIA

By Earl V. Shannon

1. Augite from diabase; section on *b*(010) showing twinning and parting parallel to *a* (100) and close parting parallel to *c* (001), also showing extinction of 45° producing simultaneous extinction in both halves of the twin ---------- 12

Page

2. Quartz—showing highly modified development of quartz crystals occurring in miarolitic cavities 41
3. Albite—showing common habit of albite crystals occurring in miarolitic cavities 43
4. Diopside; prismatic crystal from miarolitic cavity 44
5. Albite; showing prismatic development of colorless transparent albite crystals occurring in fractures and veins 55
6. Epidote. Crystallographic drawing in clinographic and orthographic projection of epidote of the hourglass type 58
7. Epidote. Sketch showing optical directions and hourglass structure. Projection on *a* (100) 58
8. Epidote. Projection of "hourglass" crystals on *b* (010) showing optical orientation 59
9. Axinite. Showing common habit of crystals from Goose Creek. Orthographic and clinographic projection on *c* (010) 61
10. Prehnite. Type 1 crystal. Orthographic crystal drawings 62
11. Prehnite. Type 2 crystal elongated on the *b* axis showing crystal habit and striation of *c* (001) 62
12. Prehnite. Type 3 elongated on the *a* axis showing striation and crystal habit in orthographic and clinographic projection 63
13. Prehnite. Type 1 showing common "hourglass" form 63
14. Prehnite. Type 1 showing a modification of the "hourglass" structure where the two end sectors are not connected 64
15. Prehnite. Type 1 showing "hourglass" structure in a crystal bounded only by pinacoids 64
16. Prehnite. A variant of type 1 showing the growth of thickening at the ends to produce sheaves 64
17. Prehnite. A side view of crystal aggregate similar to that shown in figure 16 65
18. Prehnite showing optical structure of crystals of type 2 65
19. Prehnite showing optical structure of crystals of type 3 65
20. Datolite of first generation showing acute habit 66
21. Datolite of second generation showing more prismatic habit by elongation on the *a* axis 67
22. Datolite of second generation showing pronounced tabular development parallel to *x* (102) 70
23. Chabazite showing unit rhombohedron, the common form at Goose Creek 71
24. Stilbite of "Epidesmine" habit bounded only by three pinacoids 72
25. Stilbite of the usual habit showing pyramidal faces 73
26. Laumontite showing common habit, the unit prism with the negative dome *e* (101) 74
27. Apophyllite of cubic form showing only prism and basal pinacoid 75
28. Apophyllite showing commonest combination of pyramid with small prism faces 76
29. Apophyllite showing combination of pyramid with faces of four prisms 81
30. Apophyllite from specimen of Merrill and Wherry showing two prisms, pyramid and base 82
31. Calcite showing the commonest habit of amber colored calcite occurring in the veins 83
32. Calcite. Habit of a single white crystal observed resting on prehnite 84

New diptera or two-winged flies in the United States National Museum

By J. M. Aldrich

Page

1. Male genitalia. *a*, *Sarcophaga subaenescens*, new species; *b*, *Sarcophaga placida*, new species; *c*, *Masicera arator*, new species; *d*, *Sarcophaga morosa*, new species 25

A rare Cretaceous sea urchin Scutellaster cretaceus Cragin

By John B. Reeside, jr.

1. Hypothetical restoration of *Scutellaster cretaceus* Cragin, based on the type and a Miocene *Scutella* 2
2. Comparison of arrangement of plates of (B) actinal side of *Scutella subrotundata* Lamarck with that of (*A*) *Scutellaster cretaceus* Cragin 3

Chinese amphibians and reptiles in the United States National Museum

By Leonhard Stejneger

1. *Phoxophrys grahami*. Type U. S. Nat. Mus. No. 65500. 2× nat. size 40
2. *Eumeces pekinensis*. Type U. S. Nat. Mus. No. 60683. 3×nat. size 49
3. *Lygosaurus sowerbyi*. Type U. S. Nat. Mus. No. 65375. 4×nat. size 53
4. *Takydromus intermedius*. Type U. S. Nat. Mus. No. 64437. 3×nat. size 59
5. Number of ventrals in *Natrix piscator*, *N. percarinata*, and *N. annularis* based on published records of 72 specimens 67
6. Number of subcaudals in *Natrix piscator*, *N. percarinata*, and *N. annularis* 67

On the occurrence of remains of fossil porpoises of the genus Eurhinodelphis in North America

By Remington Kellogg

1–4. Teeth of *Eurhinodelphis bossi*. Cat. No. 8842, U.S.N.M.×3. 1. Anterior view of tooth. 2. Posterior view of a tooth. 3. Posterior view of an anterior tooth. 4. Lateral view of a posterior tooth, apex of crown missing 20

Mineralogy and petrography of Triassic limestone conglomerate metamorphosed by intrusive diabase at Leesburg, Virginia

By Earl V. Shannon

1. Diopside. Habit of minute colorless crystals occurring in veins with datolite 19
2. Datolite. Small crystal showing common habit with apparently orthorhombic symmetry 21
3. Datolite. Similar to Figure 2 but having some negative pyramids not represented by corresponding positive forms 23
4. Datolite. Similar habit to Figure 3 but showing only positive hemipyramids 24
5. Datolite. Crystal from a specimen on which all the crystals, like the one figured, are different from the prevailing habit at the locality. Shows several unusual forms 25

Page

6. Apophyllite. Habit of minute crystals which rest on datolite ------- 28
7. Calcite. Habit of small yellowish to amber crystals ---------------- 28
8. Calcite. Habit of larger colorless crystals ------------------------ 30

A NEW GENUS OF EOCENE FORAMINIFERA

By Joseph A. Cushman

1. *Hantkenina alabamensis,* new species. Apertural view showing the median aperture and the alar projections from it toward the base -- 3

A FURTHER AND DETAILED DESCRIPTION OF THE TYPE OF ELEPHAS ROOSEVELTI HAY AND DESCRIPTIONS OF THREE REFERRED SPECIMENS

By Oliver P. Hay

1. Tooth and part of the skull referred by Osborn to *Elephas primigenius* × .25 -- 4

ON REMAINS OF MASTODONS FOUND IN TEXAS, ANANCUS BRAZOSIUS AND GOMPHOTHERIUM CIMARRONIS

By Oliver P. Hay

1–3. *Gomphotherium cimarronis* × 5. Diagrams to show position of the fangs of the roots. Viewed with crown directed downward. The numerals indicate the crests supported. 1. Upper right second molar. 2. Upper right third molar. 3. Lower left third molar -- 9
4. *Gomphotherium cimarronis.* View of base of upper right tusk, seen from outside. *mx.*, fragment of maxilla. *pmx.*, fragment of premaxilla. × .5 -- 11
5–7. *Gomphotherium cimarronis.* 5. Cross section of tusk of Figure 4, where it emerges from the skull. Seen looking toward the skull. Enamel band black. × .75. 6. Cross section of tusk 150 mm. above distal extremity. Seen looking toward skull. × .6. *a*, Enamel band; *b*, upper surface; *c*, lower surface. 7. Cross section of tusk taken 100 mm. above distal end. Seen looking toward skull. × .6. *a, b, c,* as in Figure 6 ------------------------- 11
8–9. *Gomphotherium cimarronis.* 8. Cross section of an upper tusk taken a short distance below the proximal end. The black center represents the pulp cavity; the black band, the enamel. × .6. 9. Cross section of distal end of lower jaw, showing right and left rami and the right tusk. × .57 ------------------------- 12

O

PARASITIC NEMATODES FROM TONKIN, INDO-CHINA, INCLUDING A NEW SPECIES OF ASCARIDIA

By Benjamin Schwartz

Of the Zoological Division, Bureau of Animal Industry, United States Department of Agriculture

The following report is based on a small collection of nematodes, largely from domestic animals, received from Maj. E. Houdemer, Chief of the Clinic at the École Vétérinaire at Hanoi (Tonkin) Indo-China. In addition to a new species of *Ascaridia* from the goose which is described in this paper, there were found a species of *Rictularia* from a rat which is probably a new species, and specimens of the genus *Porrocaecum* from a heron (genus and species unknown) which require further study.

Superfamily OXYUROIDEA

Family OXYURIDAE

Genus OXYURIS Rudolphi, 1803

OXYURIS EQUI (Schrank, 1788)

Host.—Equus caballus.

Location.—Unknown.

Only short-tailed forms were found, but Major Houdemer states that long-tailed forms also occur in horses in Tonkin.

Superfamily ASCAROIDEA

Family ASCARIDAE

Genus ASCARIS Linnaeus, 1758

ASCARIS LUMBRICOIDES Linnaeus, 1758

Host.—Homo sapiens.

The specimens which are sexually immature were vomited by a breast fed infant (native) only two months old.

Genus BELASCARIS Leiper, 1907

BELASCARIS CATI (Schrank, 1788)

Host.—Panther (*Felis*, species).
Location.—Intestine.

Genus PORROCAECUM Railliet and Henry, 1912

Host.—"Crabier," a species of heron.
Location.—Esophagus, stomach, intestine.
More than one species of *Porrocaecum* is present in the lot.

Family HETERAKIDAE

Genus HETERAKIS Dujardin, 1845

HETERAKIS BERAMPORIA Lane, 1914

Host.—*Gallus domesticus.*
Location.—Cecum.

This species was described from the cecum of the domestic fowl at Berhampore, Bengal, India. It was also found by the present writer to be a common parasite of chickens in the Philippine Islands, often living in association with a related species (*Heterakis gallinae=H. papillosa*) from which it may be differentiated by its smaller size and by the fact that its spicules are considerably shorter and nearly equal in length.

The present writer also found that the larvae of this parasite occur in nodules that are located in the wall of the cecum, principally in the submucosa.

It may be noted in this connection that Travassos (1920) includes the Heterakidae, from which he excludes the genus *Ascaridia*, with the Oxyuroidea, largely on the basis of the esophageal bulb.

Genus ASCARIDIA Dujardin, 1845

ASCARIDIA LINEATA (Schneider, 1866)

Hosts.—*Gallus domesticus*, *Anser domesticus.*
Location.—Intestine.

This species was described from Brazil from the intestine of *Gallus domesticus.* Von Linstow (1883) records this species from the same host in Turkestan. Travassos (1913) describes *Ascaris lineata* from the common fowl in Brazil, the type locality of this species, and records the length of the spicules as 1.4 mm. This species has also been recorded from the Belgian Congo and from Europe. Recently Boulenger (1923) records this species from Zanzibar, having found a single specimen (male) in the stomach of the domestic fowl. Boulenger calls attention to the fact that the figures of different authors do not agree in all details as

regards the shape and direction of certain papillae in the male and ascribes these differences to individual variation. Thus, Schneider (1866) figures the most cephalad papilla rounded in shape, whereas Von Linstow, Boulenger, and Travassos figure it as being transversely elongated. With regard to the direction of the second lateral papilla there is also a diversity of views, since Schneider and Boulenger figure it as being directed ventrally, whereas Von Linstow and Travassos figure it as being directed laterally. Boulenger also regards *Ascaridia hamia* Lane, 1914, a synonym of *Ascaridia lineata*, and the present writer concurs in this opinion. Lane's figure shows the second lateral papilla directed laterally and his drawing of the most cephalad papilla agrees with that of Schneider.

Specimens examined by the present writer show considerable variation as regards the shape and direction of certain papillae as well as regards the size of the spicules. In immature specimens from the goose the spicules are from 530μ to 570μ long, the second lateral papilla being directed ventrally in some specimens, and having a lateral direction in others. In larger, though still immature specimens, from the chicken, the spicules are from 700μ to 800μ long, and the second lateral papilla is directed laterally. The first ventral papilla is transversely flattened in most specimens examined by the present writer, although in one immature specimen it was found to be rounded, agreeing in shape with this papilla as figured by Schneider and Lane. Sexually mature specimens of *Ascaridia lineata* from the chicken agree in practically all respects with the description of *Ascaridia hamia* Lane, which is also based on mature specimens. In my specimens the spicules are up to 2.4 mm. in length whereas Lane gives the length of the spicules as 2 mm. The sucker is 0.2 mm. in diameter, according to Lane, this measurement agreeing with that of Boulenger, so far as can be judged from the latter's figures. In specimens examined by the writer the sucker showed considerable variation, being only 0.15 mm. in diameter in immature specimens and attaining a diameter of 0.25 mm. in large sexually mature forms.

The females also show considerable variation as regards the length of the tail (from 0.5 mm. to 1.5 mm. depending upon the size of the specimens) and as regards the length of that portion of the vagina that extends cephalad (from 0.425 mm. to 1 mm.), the shortest distance corresponding to the youngest forms and the longest distance to the largest forms. Similar variations were found as regards the distance of the excretory pore and nerve ring from the cephalic extremity the length of the tail in the male, and in other characters.

In this connection it may be noted that according to Travassos (1920) the genus *Ascaridia* belongs to the family Ascaridae and is placed in a distinct subfamily (Ascaridinae) on the basis of the

structure of the esophagus which is without a bulb. The fact that the members of this genus have a pre-anal sucker and a bursa-like tail in the male has been generally considered sufficient ground to warrant their inclusion in the Heterakidae, and this classification is followed by most helminthologists.

ASCARIDIA ANSERIS, new species

Male.—32 mm. long by 600μ wide. Cuticle finely striated. Head, separated from rest of body, 172μ wide, measured near the base. Esophagus simple, 1.75 mm. long by 285μ in maximum width. Nerve ring about 350μ from cephalic extremity. Sucker circular, 138μ by 130μ, its posterior margin being located at a distance of 172μ from the anus and at about 700μ from the posterior extermity. On one side of the body there are 14 papillae of which 5 are pre-anal and 9 post-anal (fig. 1). The first three papillae are ventral in position and are arranged in a row on each side of the sucker the most cephalad papilla being anterior to the sucker, the middle one lying in the region of sucker and the last papilla being posterior to the sucker. Of the next two papillae, one is ventral and one is lateral (*1l*). In the following group of three papillae one is lateral (*2l*) and two appear to have a ventral position. Of the remaining 6 papillae four are lateral (*3l*, *4l*, *5l*, *6l*) and two ventral. The distances between the tips of the first four lateral papillae are almost equal and greater than the distance between the last two lateral papillae.

The papillae on the other side of the worm are only 13 in number, the corresponding first lateral papilla being absent. The remaining papillae, though corresponding in number to those on the opposite side, show in some respects a different arrangement; the third lateral papilla appears to be absent, being replaced by a ventral papilla (*x*). The fourth, fifth, and sixth lateral papillae correspond to those on the opposite side.

The spicules nearly equal, 820μ and 827μ long, respectively, and terminate bluntly. The tip of the tail in my specimen is broken off, as can be seen from the jagged posterior extremity in the illustration.

Female.—Unknown.

Host.—*Anser domesticus.*

Location.—Small intestine.

Locality.—Hanoi (Tonkin) Indo-China.

Type specimen.—U. S. National Museum Helminthological Collections No. 26011.

Variation in number and in position of papillae in the genus *Ascaridia* is apparently not uncommon. In *Ascaridia columbae*, as recently figured by Baylis and Daubney (1922), the papillae show considerable variation in position. It is not improbable that the

asymetrical arrangement of the papillae in the specimen of *A. anseris* is an abnormality.

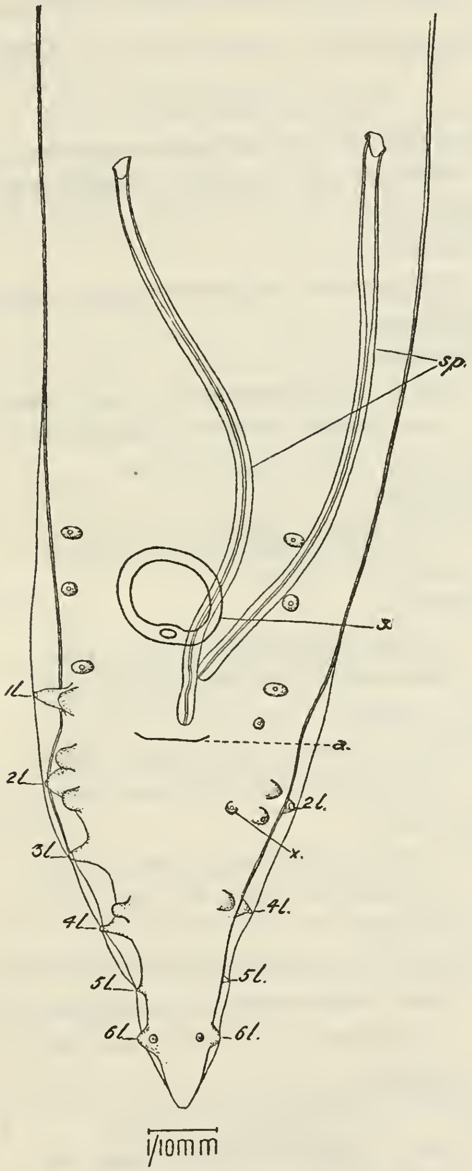

FIG. 1.—ASCARIDIA ANSERIS (TAIL OF MALE): *a*, ANUS; *s*, SUCKER; *sp.*, SPICULES; *1l–6l*, FIRST TO SIXTH LATERAL PAPILLAE, RESPECTIVELY; *x*, ACCESSORY VENTRAL PAPILLA

Lane (1914, 1917) has limited the definition of the genus *Ascaridia* to species having 10 pairs of papillae in the male. If Lane's suggestion were followed it would be necessary to create new genera presumably on the basis of the number of papillae in the male, as

these differ in number in certain species. For the present, at least, it seems more advisable to adhere to the conception of the genus *Ascaridia* as defined by Railliet and Henry (1914).

Superfamily STRONGYLOIDEA

Family STRONGYLIDAE

Genus PROTERACRUM Railliet and Henry, 1913

PROTERACRUM VENULOSUM (Rudolphi, 1809)

Host.—*Capra hircus.*
Location.—Intestine.

PROTERACRUM COLUMBIANUM (Curtice, 1890)

Host.—*Capra hircus.*
Location.—Intestine.

Genus ANCYLOSTOMA (Dubini, 1843)

ANCYLOSTOMA CANINUM (Ercolani, 1859)

Hosts.—*Felis tigris* and *Canis familiaris.*
Location.—Intestine.

ANCYLOSTOMA BRAZILIENSE (Gomez, 1910)

Host.—*Panther* (*Felis*, species).
Location.—Intestine.

Genus STRONGYLUS Goeze, 1782

STRONGYLUS EQUINUS[1] (Mueller, 1780)

Host.—*Equus caballus.*
Location.—Unknown, presumably cecum or colon.

STRONGYLUS VULGARIS (Looss, 1900)

Host.—*Equus caballus.*
Location.—Unknown, presumably cecum or colon.

STRONGYLUS VULGARIS Looss, 1900)

Host.—*Equus caballus.*
Location.—Unknown, presumably cecum or colon.

Genus TRICHONEMA Cobbold, 1874

TRICHONEMA NASSATUM le Roux, 1924

Host.—*Equus caballus.*
Location.—Unknown, presumably cecum.

Genus CYLICOSTOMUM Looss, 1901

Subgenus CYLICOCERCUS Ihle, 1922

CYLICOCERCUS CATINATUS (Looss, 1900)

Host.—*Equus caballus.*
Location.—Unknown, presumably cecum.

[1] The five species of horse strongyles were determined by Miss E. B. Cram of this division.

Family TRICHOSTRONGYLIDAE

Genus MECISTOCIRRUS Railliet and Henry, 1912

MECISTOCIRRUS DIGITATUS (v. Linstow, 1906)

Host.—*Bos taurus.*

Location.—Stomach.

The spicules are nearly 6 mm. long, this size being larger than has heretofore been recorded for this species. According to Railliet and Henry (1912) the spicules of this species are from 3.8 mm. to 4.5 mm. long. These writers disagree with Leiper as regards the identity of *M. digitatus* and *M. fordi* and differentiate the two species as follows:

M. fordi has longer spicules (6.2 mm. to 7.5 mm. long); its bursa is almost as wide as long whereas the bursa of *M. digitatus* is almost twice as long as it is wide. Railliet and Henry state moreover that the projecting lobule that is present at the level of the external dorsal ray in *M. fordi* is absent in *M. digitatus.*

Family METASTRONGYLIDAE

Genus DICTYOCAULUS Railliet and Henry, 1907

DICTYOCAULUS VIVIPARUS (Bloch, 1782)

Host.—*Bos taurus.*

Location.—Bronchi.

Superfamily SPIRUROIDEA

Family RICTULARIIDAE

Genus RICTULARIA Froelich, 1802

Host.—"Rat."

Location.—Stomach.

Family PHYSALOPTERIDAE

Genus PHYSALOPTERA Rudolphi, 1819

PHYSALOPTERA PRAEPUTIALIS v. Linstow, 1889

Host.—*Felis domestica.*

Location.—Stomach.

Superfamily FILARIOIDEA

Family FILARIIDAE

Genus DIROFILARIA Railliet and Henry, 1911

DIROFILARIA IMMITIS (Leidy, 1856)

Host.—*Felis tigris.*

Location.—Right side of heart.

This is a new host for this parasite, which has, however, on several occasions, been reported from *Felis domestica.*

Genus SETARIA Viborg, 1795

SETARIA EQUINA (Abildgaard, 1789)

Host.—*Equus caballus.*
Location.—Unknown.

SETARIA, species

Host.—*Equus caballus.*
Location.—Eye.

A single immature female specimen from the eye of the horse. The posterior end is smooth, as in *Setaria digitata*, but there is no terminal knob. The specimen in question is probably *Setaria digitata* (v. Linstow, 1906). This nematode was originally described from Ceylon, and has also been recorded from India. It is possible that the terminal knob appears only in mature forms, presumably as a result of a constriction in the cuticle in the posterior region.

Heretofore young filarids from the eye of the horse have been found to be *Setaria labiato-papillosa* by Railliet and Henry (1911). According to Bauche and Bernard (1912) young forms of *Setaria labiato-papillosa* occur in the eye of the horse in Anam.

Family THELAZIIDAE

Genus CHEILOSPIRURA Diesing, 1861

CHEILOSPIRURA HAMULOSA (Diesing, 1851)

Host.—*Gallus domesticus.*
Location.—Gizzard.

Several female specimens were found under the horny lining of the gizzard, firmly attached to the inner surface of the lining.

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O

THE MINERALOGY AND PETROLOGY OF INTRUSIVE TRIASSIC DIABASE AT GOOSE CREEK, LOUDOUN COUNTY, VIRGINIA.

By Earl V. Shannon,
Assistant Curator of Geology, United States National Museum.

INTRODUCTION.

The present paper records observations made on several trips to the Goose Creek trap quarry, together with the results of a large amount of office and laboratory study of the specimens collected. The data thus acquired have become somewhat voluminous and, since other duties are forcing attention, it is considered best to present the results thus far attained while they are fresh in mind. My work does not by any means exhaust the locality but merely serves as a starting point from which study of the interesting features may be continued. The locality is a pleasant journey from Washington and is recommended to any petrologist or mineralogist seeking an educational day's outing in the field to relieve the monotony of office routine.

ACKNOWLEDGMENTS.

I have enjoyed an unusual amount of cooperation in preparing this paper and it seems appropriate to make some acknowledgments. For the suggestion that the locality would be found worthy of study I have to thank Dr. George P. Merrill. One of my visits to the quarry was made in company with the following members of the Mineralogical Society of Washington: W. F. Foshag, W. S. Burbank, Frank L. Hess, Esper S. Larsen, jr,, Clarence S. Ross, Edward Sampson, Waldemar T. Schaller, Edgar T. Wherry, and Ralph W. G. Wyckoff. Observations and opinions of all of these men and specimens collected by them have been at my disposal. In addition to the help of the above scientists, various points have been discussed with Dr. Norman L. Bowen, who has pointed out similarities to his Gowganda Lake area, and with Drs. Herbert E. Merwin and Clarence N. Fenner, who are familiar with the locality. I have especially to thank Drs. Esper S. Larsen and Clarence S. Ross for constant advice

and help in interpreting the various phenomena and in the microscopic work, Dr. Henry S. Washington for courteously reviewing that part of the discussion which deals with the quantitative classification, and Dr. Edgar T. Wherry for carefully reading and editing the manuscript. To Harry Warner and Frank Reid, preparators for the National Museum and Geological Survey, I am indebted for the skillful preparation of the numerous thin sections required. Finally, I would acknowledge as the work of J. S. Olmstead, photographer of the National Museum, the excellent natural-size photographs here reproduced. The photomicrographs I myself took in the Department of Geology laboratory.

LOCATION.

The locality in question is a quarry opened in the diabase for "trap rock" which is crushed and sold for road making, and is alongside the right of way of the Washington & Old Dominion Electric Railway just east of Goose Creek, about 6,400 meters (4 miles) southeast of Leesburg. The quarry is about 800 meters (½ mile) northwest of Belmont Park Station.

GENERAL RELATIONSHIPS.

No attempt was made to work out any areal geology except to casually examine a few outcrops in the general vicinity. The locality is within the Harpers Ferry Quadrangle described by Keith. The outcrop of the diabase as shown on Keith's map is extremely irregular with a maximum width at the south of the quadrangle of about 6,400 meters (4 miles). The section shown as crossing the diabase sheet about 8,000 meters (5 miles) to the south of the quarry indicates an intrusive mass of sill-like form, in general conformable with the bedding, having a thickness computed from the section of some 750 meters (2,400 feet). The quarry here described lies within a few dozen meters of the eastern edge of the outcrop and hence is presumably practically at the base of the sill. The ridge on which the quarry is situated is entirely composed of the trappean rock. The next ridge to the east is seen, where cut through for the railroad, to consist of baked and mottled Triassic shale, while the intervening vale is devoid of exposures. Keith gives a brief description of the diabase[1] stating that it is intrusive with a maximum width of possibly 250 meters (800 feet). If it actually is as thin as this the base must be somewhat flatter than shown on his section. The Triassic rocks of Virginia are now being studied for a report to be published by the Virginia Geological Survey. A preliminary paper on the diabases, including the diabase pegmatites

[1]Arthur Keith, Harpers Ferry Folio, Folio 10, U. S. Geol. Surv.

of Goose Creek quarry, has been published by Roberts.[2] In this paper this mass of intrusive diabase is named the Belmont Stock.

GENERAL DESCRIPTION.

The quarry exposes no contacts of the intrusive rocks with the nclosing sediments. The material exposed consists in greatest part of the igneous rock, described below as normal diabase. Next in abundance comes a rock which does not differ greatly in composition from the normal diabase but which is very coarse grained, the material of the maximum coarseness containing augite blades 25 cm. (10 inches) in length and 3 cm. in width. A third type comprises other masses, usually of small size, with a similar coarse texture but consisting in the main of albite and quartz, the titaniferous augite which is characteristic of the first two types being more or less completely replaced by diopside. This type is considered to be in part an end differentiate of the coarse second type and in part a hydrothermal alteration product. The masses of the third type contain small miarolitic cavities lined with contemporary crystals of quartz, albite, titanite, and diopside, usually also with a later series of minerals consisting of fine fibrous hornblende, epidote, chalcopyrite, and chlorite. The fourth rock type consists also mainly of quartz and albite, and occurs in narrow dikes of aplitic habit filling persistent narrow cracks in the normal rock. These dikes are considered to be essentially of the same origin as the magmatic third rock type, the principal difference being the textural change caused by their intrusion into narrow cracks.

All of the rock types considered are cut by numerous joints and fissures. Adjacent to these there is hydrothermal alteration of the inclosing rocks of various types which are discussed below, and the cracks and open spaces themselves are filled with minerals deposited from solution. These minerals, which are described individually in detail in the following pages, consist of several varieties each of hornblende and chlorite; epidote, albite; the sulphides, galena, chalcopyrite, pyrite, and possibly pyrrhotite; diopside, axinite, datolite, prehnite, apophyllite, quartz, calcite, laumontite, chabazite, stilbite, etc. There appears to be represented in the limits of the quarry a gradation from the original crystallization of the normal diabase through a series of magmatic differentiates into high temperature hydrothermal deposits, represented by the hornblende in cracks and the minerals in the miarolitic cavities. The latter overlap a sequence found in the veins which grades into the series of minerals characteristic of typical zeolitic deposits.

[2] Joseph K. Roberts, Jurassic Intrusives of Virginia. Pan-American Geologist, vol. 39, pp. 289-296, May, 1923.

DETAILED DESCRIPTION.

OUTLINE.

The following detailed description may be represented by the following outline although the treatment does not strictly adhere to the outline in its entirety.

1. Jointing and fissuring.
2. Normal diabase.
    - *a.* Macroscopic features.
    - *b.* Texture.
    - *c.* Minerals.
        - (1). Feldspar.
        - (2). Pyroxene.
        - (3). Accessories.
            - (*a*) Iron ore.
            - (*b*) Biotite.
            - (*c*) Quartz and micropegmatite.
            - (*d*) Apatite.
3. Diabase Pegmatite. Definition.
    - *a.* Macroscopic features.
    - *b.* Texture.
    - *c.* Minerals.
        - (1) Feldspar.
        - (2) Pyroxene.
        - (3) Accessories.
            - (*a*) Micropegmatite.
            - (*b*) Ilmenite, Iron ore.
            - (*c*) Biotite.
            - (*d*) Apatite.
            - (*e*) Alteration products.
4. Albitic pegmatites—definition.
    - *a.* Macroscopic features.
    - *b.* Texture.
    - *c.* Minerals.
        - (1) Feldspar.
        - (2) Micropegmatite.
        - (3) Pyroxenes.
        - (4) Titanite.
        - (5) Apatite.
    - *d.* Composition.
    - *e.* Origin and comparison.
5. Aplitic albite rocks.
    - *a.* Occurrence, size.
    - *b.* Macroscopic features.
    - *c.* Microscopic features, texture.

5. Aplitic albite rocks—Continued.
    d. Minerals.
        (1) Quartz.
        (2) Feldspars.
        (3) Diopside.
        (4) Epidote.
        (5) Alteration products.
    e. Discussion, Origin.
6. Miarolitic cavities.
    a. Occurrence, size.
    b. Original minerals.
        (1) Quartz.
        (2) Albite.
        (3) Diopside.
        (4) Titanite.
    c. Second generation minerals.
        (1) Hornblende (byssolitic).
        (2) Chalcopyrite.
        (3) Epidote.
        (4) Chlorite.
    d. Discussion of origin.
7. Hydrothermal alteration along seams and fissures.
    a. Diopside-filled cracks accompanied by diopsidization of the adjacent diabase.
    b. Chlorite seams accompanied by hornblendization of the normal rock.
    c. Hornblende-filled cracks without alteration of the adjacent diabase.
    d. Bluish hornblende coatings on fracture surfaces.
    e. Alteration of normal diabase adjacent to zeolite-bearing veins.
    f. "Diabantite varnish" on slickensided joints.
    g. Alteration of diabase pegmatite where intersected by diopside seams.
    h. Hornblendization of normal diabase pegmatite along cracks and seams.
    i. Hornblendization of diopside of albite-diopside pegmatite rocks.
8. Hydrothermal joint and cavity fillings.
    a. Occurrence.
    b. Minerals.
        (1) Albite.
        (2) Chlorites.
        (3) Hornblende (byssolitic).
        (4) Epidote.

8. Hydrothermal joint and cavity fillings– Continued
    b. Minerals.—Continued.
        (5) Axinite.
        (6) Quartz.
        (7) Prehnite.
        (8) Datolite.
        (9) Chabazite.
        (10) Stilbite.
        (11) Laumontite.
        (12) Opal-hyalite.
        (13) Apophyllite.
        (14) Galena, Pyrite, Calcite.
    c. Paragenesis.
    d. Origin.

JOINTING AND FISSURING.

The diabase exposed in the walls of the quarry is very strongly dissected in what seems, at first glance, to be an intricate complex of joints and fractures. More thorough study resolves this fracturing into two relatively simple systems. For convenience of description and reference these have been designated the north-south joint system and the east-west fissures.

The north-south joint system is a series of closely spaced, steeply dipping joints which slice the diabase into slabs of the magnitude of 50 cm. in thickness, the variation being from 10 cm. to 100 cm. At the southwest corner of the quarry these joints, which are very pronounced, have an average strike of N. 15° E. and dip 60° to 65° east. At the northwest corner these joints, which are not nearly so well defined or so well exposed, seem to strike about N. 15° W. and to dip east at 85°. In the main face of the quarry, which is more or less parallel with the strike of this joint system, they vary in strike from about N. 15° E. to N. 30° E. and dip from 70° to 80° west. The change from east to west dip in this joint system is not gradual but in the south quarry wall is seen to take place suddenly at a fissure marked by a considerable zone of shearing. This break seems to extend in a north-south direction across the floor of the quarry and probably intersects the north wall in a notch marked by unusually deep weathering.

The joints are almost invariably coated by a black shining and slickensided veneer of the chlorite here referred to diabantite. This coating, which may be lumpy, fibrous or grooved, is usually from one to five millimeters thick and consists of the chlorite in relatively pure form. There is relatively little crushing along the north-south direction, although occasionally a joint thickens into a zone of sheared rock from 5 to 30 cm. wide. One such streak of sheared rock in the

southwest corner of the quarry was seen to contain diabantite-coated fragments with interstitial apophyllite, datolite, and calcite; and one in the northeast corner furnished calcite, datolite, prehnite, laumontite, and stilbite. The rock adjacent to these joints is for the most part fresh and free from indications of high temperature hydrothermal alteration. It is not believed that any single north-south joint has been the locus of any great movement. However, such a closely spaced joint system, where each fracture contributed its share to the total, might have resulted in a large aggregate movement, and this would be aided by the diabantite which would serve as a lubricant to facilitate slipping with a minimum of crushing. The general slickensiding of the susceptible diabantite may well be the result of a long series of relatively slight creepings of adjacent blocks.

What is here designated the east-west fissure system consists of a number of somewhat irregular or curved fractures varying in strike from N. 30° W. to N. 75° W. with a dip of from 75° to 85° northeast. These are not close spaced enough to be designated a joint system, well marked breaks being separated by an average distance of 10 meters. There are many features which differentiate these fractures from the north-south joints, even when, as sometimes happens, the two coincide approximately in strike. The east-west fissures have more the appearance of sharp breaks and are more frequently accompanied by crushed and sheared zones. They are not notably slickensided, mainly because they are not coated with the easily polished diabantite. The coating on the surfaces is mostly light colored in tones of gray to blue-green or gray-green, and consists in the main of finely fibrous hornblende or of a light gray-green chlorite which contrasts sharply with the glossy black of the diabantite varnish on the north-south joints. All of the aplites seen in place occupied or were parallel to the east-west fractures and in some places coarse "pegmatite" phases seemed somewhat aligned in this direction. Moreover the east-west system seems characterized by more hydrothermal alteration contiguous to the joints. The various later secondary hydrothermal vein minerals, including prehnite, datolite, apophyllite, and zeolites appear to be developed along shears in this direction somewhat more frequently than along the north-south joints. Although most of the specimens of such minerals which were studied came from broken piles of rock, the system of fractures in which they occurred was indicated in the altered nature of the inclosing diabase, the material from the north-south system being much darkened by diabantite coatings, while the hydrothermal alteration of rock from the east-west fissures has resulted in a bleached and chalky appearance.

The relative age of the two systems above considered is not established entirely. There is, as has been mentioned, an occasional

vague tendency of the coarse diabase masses to be aligned in the east-west direction, which might indicate that the east-west fractures had their inception during the final consolidation of the diabase. In most of the cases where the coarse rock bears a strictly intrusive relation to the inclosing diabase of normal grain the streaks are either extremely ragged or irregular, or fill fractures of very flat attitude, which seems to indicate that few if any of the steeply dipping breaks were in existence at the time of their intrusion. The aplitic dikes, however, tend unmistakably to follow the east-west fissures and conclusively date this series of fractures with the final magmatic stages when the products of differentiation at an accessible distance were still fluid enough to be forced along cracks. The aplites are few in number, but many of them have been affected by a type of hydrothermal alteration, which is probably indicative of high temperature. This alteration is not confined to the vicinity of the relatively few cracks which contain aplitic material, but is conspicuous adjacent to many other cracks where there is no igneous material and is rather universally present contiguous to the east-west fissures and their subsidiary cracks, the hornblendic veneer, which is a characteristic of these fissures, being in all probability a manifestation of this hydrothermal process, as discussed in detail below.

So far as observed, no aplitic injection follows the north-south joint system, nor is there much high temperature alteration with development of hornblende, secondary titanite, or other minerals considered as indicative of high temperature hydrothermal processes, contiguous to fractures of this system. The diabantite is considered to be a relatively late and low temperature mineral, and the earliest vein mineral seen in the shear zones of the north-south system is datolite.

For these reasons the east-west system of fractures is assumed to be older than the north-south joint system. Opposed to this conclusion is the appearance that the north-south joints are truncated by the strong east-west fractures. This is not a serious contradiction, however, since the fissures may have accommodated movements at intervals down to the present. That repeated movements took place is shown by the aplites, intruded along fractures, being sliced by subsequent movements, the later cracks being filled with secondary minerals.

In the above the postulation of two distinct systems of stresses has been inferred, a necessity more apparent than real. It is entirely conceivable that strong compressive stresses operating in a northwesterly or westerly direction and finding relief in the east-west fractures might induce the strong jointing in a direction perpendicular to the direction of compression.

As a necessary complement of the strong divisions of the rock by both north-south joints and east-west fractures there developed numerous cracks of various attitudes, mainly at a small inclination to the horizontal, connecting the steeply dipping breaks. These were relieved of the necessity of accommodating movement after the formation of the major fractures and were consequently readily healed by minerals deposited from solution. Examination of the walls of the quarry is more or less unsatisfactory, a large part of the standing rock being bounded either by north-south joints or east-west fractures in which the structure of the rock is concealed by diabantite or hornblende coatings. Rock thrown down by blasting furnishes the best cross sections of the blocks between the veneers. These broken blocks tend to split along the lines of weakness formed by the old mineral-healed cracks. This results in the exposure of druses of various minerals, the drusy surface of a block uniformly coated with a layer of a single mineral sometimes amounting to 10 square meters or more. The original attitude of these druses was somewhat in doubt until chabazite- and calcite-coated druses were seen in place as horizontal connecting seams between steep north-south joints in the southwest corner of the quarry. Usually the druses are occupied by a single mineral so that they yield little paragenetic evidence. Among the most common druse minerals are hornblende, chabazite, stilbite, laumontite, and calcite. Chabazite and one variety of hornblende are found in no other form. In a few cases calcite chabazite, and stilbite occupy the same druses, one overlying the other. Most of the druse minerals are not notably different from the same minerals which form the fillings of open spaces in shear zones. They are described in detail below under the head of hydrothermal vein fillings.

NORMAL DIABASE.

Although not possessing a strictly diabasic texture, the rock making up the body of the intrusion will be designated diabase, especially since most of the intrusive rocks of the Triassic of similar attitude and composition have long been referred to in the literature as diabase; and to call the present intrusion a gabbro or diorite, which it approaches in texture might lead to some confusion.

The normal rock was studied in some 15 specimens and thin sections from various parts of the quarry and in three specimens collected for comparison from the point where the Belmont Park road joins the Leesburg Pike 2,000 meters ($1\frac{1}{4}$ miles) northeast of the quarry.

The rock is medium gray in the hand specimen and white feldspar and greenish black pyroxene are easily distinguishable under a lens. The average grain size throughout the quarry is about 1 millimeter,

except in the extreme northern part, where it coarsens perceptibly to an average grain diameter of 2 mm. It is noticeable that where the grain of the rock is coarse there are no pegmatites.

Under the microscope the essential constituents of the diabase are seen to be pyroxene and plagioclase. The texture is dioritic, both the feldspar and the pyroxene tending to euhedral development. Distinct dibase or ophitic textures are lacking, and, although the proxene is not sufficient in amount to form a mesh, it has not crystallized definitely after the feldspar, the crystallization of the two minerals probably being more or less simultaneous. The texture is illustrated in the photomicrograph, plate 4, upper.

The feldspar, which is the most abundant constituent, occurs in lath-shaped crystals variously oriented, although at one place diabase was seen which had a parallel orientation of the feldspar yielding a faint schistosity and tendency to cleavage in one direction. The plagioclase is, for the most part, unaltered in the body of the rock away from seams and veins, and is all twinned on the albite law with medium broad twin lamellae. Grains showing also carlsbad and pericline twinning occur but rarely. Chance sections suitable for determination of the plagioclase by measurement of extinction angles are rare. One section showing the combination of albite and carlsbad twinning gave extinction indicating the composition $Ab_{35}An_{65}$. Study of the powdered rock by the immersion method shows the feldspar to be rather constant in composition, the optical properties determined being: Biaxial positive (+), 2V large, indices of refraction $\alpha = 1.555$, $\beta = 1.560$, $\gamma = 1.565$, the composition indicated being that of an acid labradorite, $Ab_{47}An_{53}$. Another determination on the feldspar separated from the coarse phase at the north end of the quarry gave $\beta = 1.563$, corresponding to the composition $Ab_{42}An_{58}$.

The alteration of the feldspar most frequently seen is by the development of nests of rather coarse flakes of a micaceous mineral of high birefringence as further discussed under the various types of hydrothermal alteration below.

The pyroxene is all characterized by a more or less distinct pinkish brown color in thin section, probably caused by the titanium content. That in the rock from the quarry is not pleochroic, although a part of the pyroxene of the rock from the side of the Leesburg Pike shows a faint pleochroism in pale violet brown and pale green. Normally the pyroxene is transparent and free from inclusions. In many sections, however, much of the pyroxene is darker in color due to the presence of numerous microscopic opaque inclusions distributed in planes parallel to the basal pinacoid *c* (001) and probably connected with incipient alternation. In sections normal to the prismatic elongation the augite shows euhedral bounding by the unit prism *m* (110) and the pinacoids *a* (100) and *b* (010) often with twinning parallel to

a (100). Cleavage parallel to *m* (110) is well developed. The pyroxene from all parts of the quarry is of uniform composition, as shown by the constancy of optical properties. That from the coarse (2 mm. grained) rock which has been mentioned as being the normal rock at the north end of the quarry was separated for analysis by the use of heavy solutions and an electromagnet, yielding a product which was homogeneous pyroxene although not entirely free from fine dustlike inclusions. Upon analysis this gave the results and ratios of columns I and II of the following table. Analyses of pyroxenes separated from other Triassic diabases are quoted, for comparison, in the other columns of the table.

Analyses of pyroxenes separated from Triassic traps.

Constituent.	1	2		3	4	5
SiO_2	50.26	0.838		47.72	48.54	50.71
TiO_2	.80	.010	0.869			
Al_2O_3	2.10	.021		3.44	5.50	3.55
Fe_2O_3	None.			5.93	2.77	
FeO	18.20	.253		18.34	21.25	15.30
MnO	.35	.006				.81
CaO	15.56	.279	.871	11.40	10.97	13.35
MgO	13.30	.333		12.89	7.67	13.63
$(Na, K)_2O$				1.23	3.10	1.48
H_2O					.82	1.17
Total	100.57			100.95	100.62	100.00

1. Pyroxene separated from diabase of Goose Creek, Va. E. V. Shannon, analyst.
2. Ratios of analysis 1.
3. Pyroxene from diabase of Rocky Hill, N. J. A. H. Phillips, analyst.
4. Pyroxene, Rocky Hill, N. J. A. H. Phillips, analyst.
5. Pyroxene, from diabase of West Rock, New Haven, Conn. G. W. Hawes, analyst. Last three analyses quoted from J. Volney Lewis, Ann. Rept. State Geologist of New Jersey for 1907, p. 117.

While the normal fresh pyroxene of the Goose Creek diabase is characterized simply by the *m* (110) cleavage and twinning on *a* (100), most sections show a distinct very fine lamination parallel to the base *c* (001). This seems to be due to strains or pressure and in its incipient stages is only a faint parting or cleavage in the transparent crystals. With further development this becomes a strong parting with very minute polysynthetic twinning on this plane. These parting and twinning planes are particularly favorable to alteration and are frequently marked by innumerable opaque, minute, dust-like grains, probably of magnetite or ilmenite. With more alteration, films of chlorite are usually developed along these partings. The optical properties of the pyroxene are uniform with the indices of refraction

$\alpha = 1.697$, $\beta = 1.710$, $\gamma = 1.725$, 2V medium, r > v slight. The extinction $Z \wedge c$ is 43°–48°. Sections on (010) are frequently encountered where, as shown in figure 1, the basal parting is combined with twinning on (100), giving a "herringbone" appearance. Frequently these give uniform extinction in both individuals of the twin due to the extinction angle being exactly 45°, X of one individual coinciding with Z of the other, as is easily shown with a quartz wedge. In some sections the basal lamination and twinning are absent except in a line of pyroxenes across the section, and a long prismatic pyroxene which lies athwart the line may have the polysynthetic twinning where the line intersects the crystal and not in the other portions which may be clear. Along these lines there is a concentration of iron ore and biotite which are thought to be late introductions as well as secondary chlorite and other alteration products which seem to indicate the presence of minute fractures.

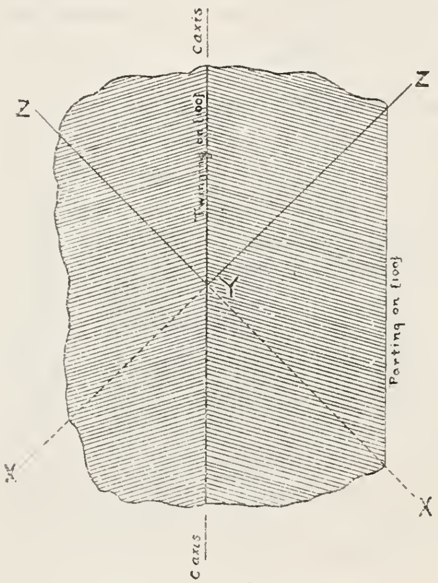

FIG. 1.—AUGITE FROM DIABASE; SECTION ON *b*(010) SHOWING TWINNING AND PARTING PARALLEL TO *a*(100) AND CLOSE PARTING PARALLEL TO *c*(001), ALSO SHOWING EXTINCTION OF 45° PRODUCING SIMULTANEOUS EXTINCTION IN BOTH HALVES OF THE TWIN.

Biotite is always present in thin sections but is never conspicuous. Occasionally a large clear-cut grain is seen, which may be an early crystallization, but usually the mineral occurs as small ragged grains grown around the boundaries of pyroxene or iron ore and more or less associated with a yellowish green fine scaly serpentinous or chloritic alteration product. The biotite may in large part be a late reaction product. It is mostly of the usual type with small axial angle, biaxial negative character, and intense pleochroism in light and dark red-brown shades, the absorption being, however, unusual in that it is greatest in the direction perpendicular to the cleavage. Some crystals are pleochroic in pale brown to almost colorless parallel to the cleavage and violet-black to greenish black and almost opaque perpendicular to the cleavage. Minute ragged grains of biotite occur mixed with grains of hornblende and opaque iron ore in altered pyroxene individuals, the biotite here evidently being a secondary product derived from alteration of the augite.

Apatite is a common though not abundant accessory. It seldom occurs in the earlier plagioclase and never in the pyroxene. One crystal of biotite contained small sharp apatite crystals. The characteristic position of the apatite is in the interstitial micropegmatite, where it forms long needle like prisms penetrating both quartz and feldspar.

Quartz is present in small amount with orthoclase, forming rare patches of fresh sharp micropegmatite occupying small angular interstices between the other minerals.

Iron ore, probably titaniferous magnetite, occurs sporadically as large irregular skeletal patches devoid of symmetry. Much of it appears to be a late introduction developed by metasomatic replacement of the earlier constituents. The fine opaque black inclusions in the pyroxene appear to be iron ore and probably formed by separation of some of the iron and titanium originally contained in the pyroxene.

A sample of the diabase from the central part of the quarry face, which, upon microscopic study, was found to be typical and unaltered was analyzed in the Museum laboratory yielding the results of column 1 of the following table. In column 2 are given the ratios of this analysis, and in the other columns there are quoted, for comparison, other analyses of Triassic diabases and basalts from localities in the Newark series.

Analyses of Goose Creek normal diabase and other Triassic traps.

	1	2	3	4	5
SiO_2	51. 56	0. 860	51. 78	50. 34	52. 68
Al_2O_3	13. 81	. 135	14. 20	15. 23	14. 14
Fe_2O_3	. 96	. 006	3. 59	2. 82	1. 95
FeO	11. 32	. 157	8. 25	11. 17	9. 75
MgO	7. 40	. 185	7. 64	5. 81	6. 38
CaO	10. 08	. 180	10. 70	9. 61	9. 38
Na_2O	2. 08	. 034	2. 14	2. 93	2. 56
K_2O	. 96	. 011	. 39	1. 02	. 88
H_2O	--------	--------	. 63	. 26	1. 60
TiO_2	1. 48	. 019	1. 41	1. 56	--------
P_2O_5	. 16	. 001	. 14	. 14	--------
MnO	. 19	. 003	. 43	. 14	. 44
Total	100. 00	--------	101. 30	101. 03	99. 76

1. Analysis of average diabase, Goose Creek, Va. E. V. Shannon, analyst. The summation (100%) is chance, all determinations being direct.
2. Ratios of 1.
3. West Rock, Conn., G. W. Hawes, analyst, Amer. Journ. Sci., vol. 9, p. 186, 1875.
4. Rocky Hill, N. J., A. H. Phillips, analyst, Amer. Journ. Sci., vol. 8, pp. 267–285, 1899.
5. Mount Holyoke, Mass., G. W. Hawes, analyst, Amer. Journ. Sci., vol. 9, p. 186, 1875.

The composition of the Goose Creek rock is shown by the analysis to be similar to that of the ordinary diabases and basalts of the Newark series. The analysis gives the following norm, calculated according to the quantitative classification.

Norm of normal diabase.

	Per cent.
Salic:	
Quartz	0. 18
Orthoclase	6. 12
Albite	17. 82
Anorthite	25. 02
Total	49.14
Femic:	
Diopside	18. 79
Hypersthene	27. 62
Magnetite	1. 39
Ilmenite	2. 89
Apatite	. 34
Total	51. 03

The rock falls in Class III, order 5, in the quantitative classification and precisely on the boundary between rangs 3 and 4 so that it can be placed either in subrang 4 of rang 3 (Camptonose), or subrang 3 of rang 4 (Auvergnose).

The norm does not differ greatly from the mode except in that the hypersthene does not occur as such in the rock but enters into the monoclinic pyroxene. There is less quartz than is to be expected from the amount of orthoclase indicated, assuming that all of the orthoclase occurs as micropegmatite. This is chiefly due to the discrepancy introduced by calculating all of the alumina as anorthite when, modally, it occurs in part in the augite as shown by the analysis of the separated mineral. It was found instructive to go through the procedure of calculating a "norm" for the analysis of the pure pyroxene separated from the diabase which gave the following results:

"Norm" of pyroxene analysis.

Ilmenite	1. 52
Anorthite	5. 84
Diopside	55. 73
Hypersthene	28. 75
Fayalite	8. 98
Total	100. 82

The interest and significance of this "norm" will be further discussed under the heading "differentiation."

DIABASE PEGMATITE.

The name diabase pegmatite is here applied to certain phases of the rock which differ from the normal diabase chiefly in the size of the constituent crystals. The name pegmatite is used in the looser

sense in which the term denotes any unusually coarsely crystalline phase of an ordinary fine grained rock where it is necessary, to account for the abrupt change in coarseness of grain, to assume the presence of some special factor, such as a greater concentration of volatile constituents or mineralizers, which has been active in promoting the growth of large crystals. The use of the name is not defended against those who favor a rigid confinement of the term pegmatite to its narrower usage to designate macrographic quartz-feldspar intergrowths or the granitic veins in which such graphic-granite occurs. It is a name which quite naturally suggested itself for the rocks described below and, it is believed, is fairly descriptive, both of their unique texture and of their most probable mode of origin. Similar rocks have previously been described under a variety of names. Emerson has termed coarse phases of diabase in the Triassic of Massachusetts plumose diabase and I have noted a similar rock from the vicinity of Westfield as coarse gabbroid diabase. Bowen called the coarse phases of the Gowganda Lake sills gabbro. Similar variants of the Duluth gabbro, however, have been described by Grout as gabbro pegmatites, and entirely analogous structures in the granite of Quincy, Mass., have been called pegmatites by Palache and Warren.

In general, the minerals of the Goose Creek diabase pegmatite are the same as those of the normal diabase into which it grades. The specimen illustrated in plate 2, lower, shows the appearance of a hand specimen trimmed from a typical mass. The most conspicuous macroscopic feature of the rock is the augite which forms long bladelike crystals set in a greenish base of feldspathic material. In average occurrences these pyroxene blades range from 4 to 10 cm. long and 4 to 8 mm. wide although occasionally much coarser rock occurs. One block found in the woods south of the railroad, where it had been thrown from the quarry by a blast, contained pyroxene crystals up to 20 cm. long and 2 cm. wide. This pyroxene is found, by optical study, to be purplish-brown titaniferous high-iron augite entirely like that of the normal diabase, an analysis of which is given above. Like the pyroxene of the normal rock, these blades show twinning on (100) and polysynthetic twinning and parting on (001). In addition to the features which it shares with that of the normal rock, the pyroxene of the diabase pegmatite possesses a well defined parting (diallagic) parallel to the (100) pinacoid. When the rock is broken this parting surface is always exhibited by the augite, and when examined carefully the parting surface shows a bronzy luster with innumerable fine transverse striations which are caused by the trace of the (001) parting and twinning. The blades almost invariably show also a narrow median line which, so far as could be determined, is a narrow

altered zone along a parting parallel to (010). The pyroxene has quite clearly crystallized before the other constituents of the rock and probably was subjected to some deforming stresses before final consolidation, for many of the blades are bent considerably. The diallagic parting, which is considered to be due to pressure, was developed before the final consolidation of the magma, because many of the larger pyroxenes are seen to have separated along this parting into leaves between which are layers of feldspathic ground mass.

The other constituents of the rock are plagioclase and micropegmatite with accessory iron ore, biotite, and chalcopyrite, all of which are, at times, visible under a lens.

Under the microscope the rock is like the normal diabase in composition except for the greater abundance of micropegmatite (pl. 4, lower). The pyroxene has the same nonpleochroic pale violet-brown color and shows the twinnings and partings previously described. The greater portion of the large blades are fresh, clear, and transparent, but there are patches where abundant minute dustlike inclusions are developed along the basal parting. Other areas sometimes show more intense alteration and are then filled with grains of iron ore and minute shreds of biotite, chlorite, and hornblende. Some partly altered blades show an outer border, in parallel position, of a hornblende pleochroic in tones of light brownish olive green and deep olive green.

The feldspar occurs as rather large crystals of plagioclase which shade outward into surrounding haloes of micropegmatite. The plagioclase is a labradorite of rather uniform composition, the β index of refraction being about 1.560 indicating Ab_{45} An_{55}. A section showing both albite and carlsbad twinning yielded extinctions indicating Ab_{40} An_{60}. The albite twinning lamellae are narrow and rather sparsely distributed. Pericline twinning is also frequently developed. There is no extensive alteration of the feldspars, although rather large irregular patches of shreds and flakes of a micaceous mineral of high birefringence are occasionally developed in them.

The micropegmatite is a prominent constituent of the rock and consists of a beautiful pattern of quartz and feldspar. There are two kinds, orthoclase micropegmatite and plagioclase micropegmatite. The plagioclase micropegmatite surrounds the plagioclase crystals and the feldspar of the central crystal is optically continuous with that of the surrounding micropegmatite, albite twinning lamellae being traceable out into the micropegmatite while crooked fingers of quartz penetrate the central feldspar crystal. The index of the feldspar in the plagioclase micropegmatite is well above that of the balsam of the slide, and the feldspar is limpid and free from alteration. Quartz-orthoclase micropegmatite is common interstitially

and is easily distinguished from the other by the fact that the feldspar, all of which has a refractive index well below that of the balsam, is muddy from the presence of minute dustlike inclusions, which are too small to be determined.

Apatite occurs sparingly as small crystals, usually disseminated in the micropegmatite.

Iron ore forms large triangular skeletal individuals, probably late replacements, which are developed regardless of the other minerals, one such spongy mass looping around feldspars, pyroxene, and micropegmatite indiscriminately as shown in the photomicrogragh (pl. 5, lower). The triangular skeletons, which average 5 mm. in diameter, are made up of plates parallel to the faces of the octahedron which indicates that the mineral is isometric magnetite rather than trigonal ilmenite, a fact further established by the fact that they are lifted by a hand magnet. Material of a large skeleton crystal ground and purified with a horseshoe magnet gave, however, a strong reaction for titanium by the hydrogen peroxide test, so that the mineral is titaniferous magnetite.

Biotite was noted in thin sections of the rock only as small flakes which are distributed around the iron ore at its contact with feldspar, and seems definitely to be a reaction product. Numerous occurrences of secondary biotite formed by reaction between iron ore and feldspar have been cited by Sederholm[3] and this seems to be a typical case. A similar relationship has been noted for a considerable part of the biotite in the diabase of normal grain. This secondary biotite of the diabase pegmatite is pleochroic in pale brown and dark greenish brown, the direction of maximum absorption being, as is usual for biotite, parallel to the basal cleavage in which it differs from the biotite seen in the normal fine grained diabase, the direction of maximum absorption in which was anomalously perpendicular to the basal cleavage. Although not seen in any of the thin sections there are nests of coarse black biotite flakes occasionally in evidence in hand specimens, which are probably original consituents of the rock. One such nest was 5 mm. across and was made up of flakes 2 mm. in diameter. This biotite is biaxial negative with 2V very small, $r < v$ strong. It is pleochroic in pale greenish brown perpendicular to the cleavage and dark greenish brown parallel to the cleavage.

The mode of occurrence of this seems to indicate that it is definitely younger than the diabase of normal grain and that it owes its peculiar features to concentration of volatile constituents, notably water,

[3] J. J. Sederholm. On Synantectic Minerals. Bull. Comm. Geol. Finland, No. 48, pp. 2–5, 1916.

into spots of greater or less size which remained fluid after the main mass of the diabase solidified and permitted the growth of large crystals producing unusually coarse textures. In places the coarse rock occurs in irregular and generally rounded to lenslike masses, sometimes of considerable size, isolated in fine homogeneous grained rock, while elsewhere coarse grained fabric forms small spots so thickly scattered as to make up approximately half of a hybrid mass of rock. Most of the larger masses, however, are tabular bodies which occur between parallel walls of the normal rock and appear to bear a truly intrusive relation to it. These vary up to 50 cm. or possibly in extreme cases to a meter in width. One such dike, which like most of them, had a rather low dip, was some 10 to 15 cm. wide and was traceable with little variation in width for 12 meters in the face of the quarry. Both ends were concealed. The dikes follow fractures of no great displacement and many of them terminate abruptly as in the small but typical example illustrated in plate 1. Another of the dikes is illustrated in plate 3.

In considering the mechanics of this segregation of the residual molten material which produced the pegmatites two hypotheses may be considered: (1) The diabase solidified in areas, each given area concentrically expelling its residual fluid molten fraction toward a center which ultimately became a chamber of considerable size filled with material which crystallized slowly, yielding rounded or irregularly lenticular bodies of diabase pegmatite. Where a fracture developed intersecting this mass previous to consolidation, the material was forced along the crack and solidified as dikelike masses of the pegmatitic rock; (2) the residual molten mineralizer-rich material was distributed generally among the individual previously solidified crystals of pyroxene and plagioclase of the diabase and, at the compression of the mass and formation of fissures this residual liquor was pressed into the fractures, there to solidify as the pegmatites. Definite proof of either mode of formation can not be advanced and it is probable that both were operative. That the material forming the pegmatites must have been forced into its present position in the dikelike masses in entirely molten form is shown definitely by the attitude of the bladed pyroxenes. While it is clear that the order of crystallization was pyroxene-feldspar-micropegmatite, the long bladed augites have in nearly all of the observed dikes grown in fingerlike arrangement perpendicular to the walls of the dike and have oriented themselves on grains of the constituent pyroxene of the wall rock. While bent and split, they do not show any flowage arrangement.

A typical sample of the diabase pegmatite was analyzed in the museum laboratory yielding the results, ratios, and norm given below:

Analysis, ratios, and norm of diabase pegmatite.

	Per cent.	Ratio.	Norm.		
SiO_2	52.94	0.881	Quartz	4.80	Salic, 57.44 per cent.
TiO_2	2.32	.029	Orthoclase	8.90	
Al_2O_3	14.80	.145	Albite	16.77	
Fe_2O_3	.16	.001	Anorthite	26.97	
FeO	12.00	.167	Diopside	9.50	Femic, 42.39 per cent.
MnO	.24	.003	Hypersthene	27.58	
CaO	8.32	.148	Magnetite	.23	
MgO	5.42	.135	Ilmenite	4.41	
K_2O	1.50	.016	Apatite	.67	
Na_2O	1.98	.032			
P_2O_5	.28	.002			
Total	99.96				

This rock falls in class III, order 5, rang 3, subrang 3, kentallenose. The greater abundance of micropegmatite is reflected in the greater amount of quartz in the norm and the higher percentages of alkalies.

Coarse phases of diabase sills have been described before from a number of localities. Those of the Gowganda Lake region described by Bowen[4] are very similar as called to my attention by Doctor Bowen himself, who, upon examination of the hand specimen of typical diabase pegmatite illustrated in plate 2, remarked that it could be duplicated from the Gowganda Lake area. His description of the rock, a gabbro, is as follows:

In places the diabase has moderately coarse phases with augite in stout prisms showing one perfect cleavage face, the diallagic parting, which determines the fracturing of the rock. The cleavage face is nearly always bent, sometimes into a considerable arc. This bending is a constant character of the augite in the coarse phase from widely separated points. Under the microscope this phase shows a nearly simultaneous crystallization of augite and plagioclase, the feldspar in broad areas generally inclosing the augite.

The feldspar is an acid labradorite Ab_{45} An_{55}, approximating that of the outer zones of the crystals of the normal diabase. Some zonal growth was shown in a few examples, the outer zone being slightly more acid.

The pyroxene is augite throughout, with cleavage parallel to 100 and a lamellar structure parallel to the base. Enstatite is absent. Both augite and plagioclase

[4] Norman L. Bowen, Diabase and granophyre of the Gowganda Lake district, Ontario. Journ. Geol., vol. 18, pp. 660-661, 1910.

are in stout prisms of about 3 mm. average length. There is no evidence of granulation of any of the constituents, so the bending of the augite must be attributed to disturbance during crystallization. A little iron ore occurs, and moderately coarse micropegmatite interstices in small amount. The feldspar of these could not be determined. Where micropegmatite is in contact with iron ore and augite, secondary biotite has sometimes been built. The rock is a gabbro near augite diorite.

No definite relation of the gabbro to the sill boundaries could be made out. There is usually a gradual passage from diabase to gabbro, but in some cases small dikelike masses of the gabbro were found in diabase. The gabbro probably represents the more slowly crystallized, slightly more acid parts of the sills. This phase is well developed in the area west of Logan Lake. In places in this area the gabbro becomes very coarse, with pyroxenes up to 3 inches in length often showing alignment, indicating motion of the mass during crystallization.

The correspondence of the foregoing with the features of the Goose Creek locality is striking. Rocks having points of similarity which occur in diabase of the Holyoke trap sheet of the Connecticut Valley in Massachussetts have been described by Emerson.[5] His description of "long plumose diabase" may be quoted to show the similarity of the augite in those phases to what has been described; although I do not agree that the large size of the augites indicates rapid growth.

One of the most remarkable of the schlieren rocks, which I have called long plumose diabase, is found only in the immediate vicinity of the breccia band, and contains filaments of the brightly rusting ankerite derived therefrom It is a coarse-grained jet-black fresh-looking rock, in which the featherlike pyroxenes have shot out in flat thin blades 3 or 4 inches long and nearly a fourth of an inch wide which radiate in plumes like a radiated actinolite. They branch at small angles and are bent gracefully or sharply twisted, as if they had shot out rapidly into the liquid glass and had been swayed in its currents like a tuft of grass leaves in the wind. A twinning plane runs down the center of each blade and close set basal partings run at right angles to the same. These have the effect of the midrib and pinnulae of a feather. The resemblance to grass is greatly heightened because the rock has been fissured across this band and many of the pyroxenes have, from weathering, turned a bright green, or even straw color and white like dry grass. This is a change to talc. This variety appears in perfection only in a narrow irregular band about 10 inches wide, traceable several feet in the ledge near the band of sandstone inclusions. This growth is essentially spherulitic although the sheaves form only a small portion of a sphere.

The pyroxene is an almost colorless sahlite which is slightly blackened by refusion at surface and along certain cleavage planes. The basal parting is very marked, and this causes the feathery appearance. The central suture is caused by twinning according to the usual law on (100), and the crystal is uniformly flattened on two of the prism faces (110), so that the twinning plane passes obliquely through the thin plate, causing the broad central suture, which completes the resemblance to a feather. The extinction is thus about 23 degrees obliquely to right and left, and an optical axis appears in the border of the field. The associated feldspar is labradorite, $Ab_3 An_4$.

[5] Benjamin K. Emerson, Plumose diabase and palagonite from the Holyoke trap sheet. Bull. Geol. Soc. Am., vol. 16, pp. 91-130, 1905.

Similiar coarsening in spots is a common phase of igneous rocks and has many times been noted in diabases and gabbros. Regarding the gabbro of the Baltimore area Williams states:[6]

The most striking feature in the texture of the unaltered gabbro is the repeated and abrupt change in the coarseness of grain which is seen at some localities. This phenomenon, as is well known, is one frequently observed in very ancient massive rocks which cover considerable areas. It was undoubtedly caused by some irregularity in the cooling of the original magma from the molten state, for which it is now difficult to find a satisfactory explanation.

Coarse phases of the Duluth gabbro have been described by Grout[7] as follows:

There are patches in the banded gabbro, especially near the base and near the top, in which the gabbro minerals have grown coarse, with grains up to 6 inches in diameter, and since the borders are ill-defined the masses may be attributed to processes of segregation. Miarolitic cavities and a little biotite may be taken as indications of the presence of mineralizers but the biotite is scarcely more abundant than in some common bands of the gabbro. The patches of notably coarse grain range from a few inches to many feet across and are estimated from incomplete exposures to be roughly ellipsoidal to somewhat tabular in form. In many places near the base the patches are numerous.

Numerous other specific occurrences could be quoted but the preceding serve to show that there is nothing unique about the coarse diabasic pegmatites of Goose Creek. The discussion of Iddings[8] is concise and pertinent:

Another case of heterogeneous texture is found in rocks often of intermediate composition, but also in others, in which in certain spots all the mineral components appear in relatively large crystals compared with those in surrounding portions of the rock. Apparently at these spots conditions existed favorable to the formation of large crystals. These were most likely molecular mobility of the magma, probably produced by a slightly greater content of gas, for a small amount that would initiate crystallization would remain in the liquid since it does not enter into the composition of the crystallizing solids.

Heterogeneous texture is characteristic of most pegmatitic rocks, especially those composed of feldspar and quartz. In them coarsely graphic fabric and radial fabric commonly mingle with granular consertal fabric, which may be equigranular in some places and inequigranular in others, often varying greatly in granularity.

There is nothing in the foregoing abstracts which is inconsistent with the conclusion that the diabase pegmatite, as described above, owes its texture to segregation of mineralizers into spots yielding a fluid gas-rich magma which remained fluid after the solidification of the surrounding diabase and permitted the growth of large crystals.

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[6] George H. Williams, The gabbros and associated hornblende rocks occurring in the neighborhood of Baltimore, Md. U. S. Geol. Survey, Bull. 28, p. 25, 1886.

[7] Frank F. Grout, The pegmatites of the Duluth Gabbro. Econ. Geol., vol. 13, p. 185, 1918.

[8] Joseph P. Iddings. Igneous Rocks, vol. 1, p. 242, 1909.

This marked the initiation of the processes which, at a more advanced stage, gave acid end-differentiates as further discussed following the description of the albite-rich phases which follow.

ALBITIC PEGMATITES.

In addition to the normal diabase pegmatite last described, there occur in the Goose Creek quarry, rocks very rich in albite which are similar in structure and occurrence to the coarse plagioclase rock. There are three principal types of these which intergrade, namely: (1) Albite pegmatite having a structure identical with that described as diabase pegmatite but in which the large crystals of feldspar are albite as is all of the feldspar of the abundant micropegmatite which they contain. In these rocks the pyroxene occurs in coarse-bladed crystals with the curved branching habit, parting and lamination of the augite of the diabase pegmatite, but the original purple augite has been more or less completely replaced by pale green diopside so that the present pyroxene is a pseudomorph of diopside after diallagic augite. The skeleton magnetites have been largely replaced by pseudomorphs of titanite. By gradual decrease in the proportion of diopside pseudomorphous after augite this rock grades into: (2) A relatively coarse albite rock containing abundant quartz-albite micropegmatite. Diopside is present in greater or less amount but is in glassy imperfect prisms which are original crystals and not alteration pseudomorphs after augite. These rocks contain frequent small miarolitic cavities, giving them a porous character, which are lined with quartz and albite crystals. These types are not sharply differentiated from: (3) A rock consisting of interlocking areas of quartz-albite micropegmatite surrounding nuclear crystals of albite, in which diopside occurs in branching fern-like graphic intergrowths with the feldspar.

The attitudes of many of the masses of albitic pegmatite are the same as those of the normal pegmatite. Typical examples of the rocks are shown in plates 6 and 8. The hand specimen shown in plate 8 composed essentially of albite and albite micropegmatite containing long blades of augite narrowly bordered by secondary diopside is in its greatest part typical of the first type, although the bottom of the specimen grades toward normal diabase pegmatite. Plate 6 shows an irregular mass of the micropegmatite-rich type containing dendritic diopsides.

A large part of the albitic rock is not of definitely demonstrable origin but a small part of the material seems clearly to be a product of post-crystallization hydrothermal alteration, while a similar small part of the occurrences are seemingly incapable of explanation as other than a product of magmatic consolidation. The greater part of the

albitic rock showing the structure of the normal diabase pegmatite is believed to be a product of secondary alteration immediately following crystallization or, if such be conceivable, a product of essentially hydrothermal action by a magma of extremely differentiated composition rich in water. This is shown by the structure, which is pseudomorphous after the pegmatite. The diopsidic pyroxene is here pseudomorphous after the augite, the titanite clearly preserves the form of the skeletal octahedrons of titaniferous magnetite and the albite-quartz micropegmatite and the albite core crystals are of precisely the form of the plagioclase-quartz micropegmatites with plagioclase cores of the normal pegmatite.

The albite with nonpseudomorphous diopsides, euhedral crystals of titanite, and miarolitic cavities; and the micropegmatite rock with plumose intergrown diopside, however, do not exhibit structure clearly traceable to the normal pegmatite and may be assumed to represent a true extreme alkalic magmatic differentiate, probably an acid residuum from the crystallization of the larger masses of normal pegmatite. The specimen illustrated in plate 6 is of interest in this connection and may be described in detail. The material of the highly albitic mass seems to have been injected with its present composition into the cavity it now occupies since it is difficult to understand how any extensive and thorough subsequent hydrothermal alteration which might have taken place could have confined itself to the contents of the cavity and failed to produce any alteration of the inclosing diabase which is perfectly fresh. It is equally difficult to conceive an extremely sodic mass of this size having formed by simple differentiation from the adjacent normal diabase. It seems to have been injected from a short distance and probably these small masses represent a little acid residuum squeezed from a considerable mass of adjacent normal pegmatite. Where seen in place in the quarry such small irregular white masses seemed always to be connected by a stringer with considerable bodies of coarse normal pegmatite.

Near the borders of this mass the pyroxenes are bronzy augite, like that of the normal pegmatite and the diabase, and these are grown outward from the walls. At their tips the pyroxenes are changed to pale green diopside, clearly pseudomorphous after the augite, with abundant inclosed large grains of iron ore. Further from the wall the bladelike diopsides inclose residual nuclei of brown augite, immediately surrounding which the diopside is enormously dusted with minute opaque grains. Around the exterior of such diopside pseudomorphs there are grouped skeletons of iron ore and crystals of titanite, the material of which was doubtless derived

from the pyroxene's alteration. The diopside around the borders of the mass is thus clearly pseudomorphous after original augite, being in fact a reaction product between previously formed basic augites and the acidic magma. The pyroxene of the main part of this rock is, however, clear green diopside which shows no evidence of derivation from original augite. It occurs as coarse graphic or plumose intergrowths with albite. While this dendritic diopside is believed to be an original consolidation product, it is possible that it also may be secondary after an original intergrowth of augite, although few augite intergrowths of this sort have been seen in the specimens studied. The diopsides of this plumose form are associated with skeletal octahedra of titaniferous magnetite and crystals of titanite, the latter somtimes replacing the former.

The feldspar, like that of the normal diabase pegmatite, is in fairly large prismatic crystals showing fine albite and pericline twin lamellae. The indices of refraction in all directions are definitely below that of the balsam and the feldspar is now entirely albite, all of which is muddy from dustlike inclusions and is also in considerable part sericitized by the growth of numerous variously orientated micaceous flakes, probably of paragonite. These nucleal crystals are surrounded by broad haloes of micropegmatite which make up the greater part of the rock (see photomicrograph, pl. 9, lower). The feldspar of the micropegmatite is also albite, in large part continuous with the feldspar of the crystal which it surrounds. It is all muddied and much of it shows a microclinelike grating structure from the combination of albite and pericline twinning. Apatite is abundant in small crystals, especially in the micropegmatite at the coalescence of two or more separate areas. Texturally this rock differs from the normal plagioclasic pegmatite chiefly in the absence of the long diallagic augites, in the presence of the dendritic diopsides, and in the much greater abundance of micropegmatite. A sample of rock having essentially the texture and composition of the central portion of the specimen illustrated in plate 6, but from a much larger mass, was analyzed. A thin section of the analyzed specimen is illustrated in the photomicrograph, plate 7, upper. This contained a smaller number of the dendritic diopside intergrowths and no visible iron ore. The larger feldspars were albite with albite and pericline twinnning, and the albite of the micropegmatite was in considerable part twinned to give the microcline grating. All of the feldspar was muddy and some of that of the groundmass had a higher index of refraction very slightly above that of the Canada balsam. The analysis, ratios, and norm of this rock are as follows:

Analysis of albitic pegmatite.

Constituent.	Per cent.	Ratios.	Norm.		
SiO_2	68.74	1.145	Quartz	23.10	Salic 83.19
Al_2O_3	13.24	.129	Orthoclase	2.22	
Fe_2O_3	1.22	.008	Albite	49.25	
FeO	1.38	.019	Anorthite	8.62	
MnO	.05				
MgO	2.02	.051	Apatite	1.34	Femic 17.61
CaO	5.90	.105	Magnetite	1.86	
Na_2O	5.76	.094	Ilmenite	1.67	
K_2O	.36	.004	Titanite	1.37	
TiO_2	1.44	.018	Wollastonite	.35	
P_2O_5	.59	.004	Diopside	11.02	
H_2O	.46				
				100.80	
	101.16				

This norm falls into class III, order 3, rang 2, subrang 5 of the quantitative classification. The extreme difference between the composition of this rock and that of the normal pegmatite is well shown by their respective norms.

The field relations of the albitic pegmatites to the normal plagioclasic diabase pegmatite deserve further study as the work in the quarry progresses from year to year. In many cases the two types of rock seem intimately mixed, probably as the result of fissuring of the main rock body during consolidation. In many of the masses the albitic rock, rich in micropegmatite, seems to be located more or less centrally within a larger surrounding mass of the plagioclase rock, which is where they should normally occur if the hypothesis of their origin here favored is correct.

An interesting example of transition from one type to the other is furnished by the specimen illustrated in plate 8. At the bottom of the plate, the base of the feathery aggregate of augite, which presumably grew outward from the wall of the chamber in which this mass consolidated, the rock contains feldspar which seems to be largely plagioclase. A short distance upward in the specimen the feldspar, both in the larger crystals and in the interstitial micropegmatite, becomes largely albite, and the borders of the augite blades are largely altered to diopside. The rock contains small miarolitic cavities and considerable amounts of chalcopyrite which has in part replaced feldspar of micropegmatite, giving quartz-chalcopyrite micrographic intergrowths. The specimen as a whole seems pseudomorphous after normal diabase pegmatite, the albite and diopside appearing to have been developed by substitution of material from a residual liquid located centrally in the pegmatite mass, although the possibility that this reaction was hydrothermal rather than magmatic is by no means precluded, nor is it certain that the albite of the rock is not a product of original magmatic consolidation.

Another example of transition from normal diabase pegmatite to the albitic rock if furnished by a narrow persistent dike exposed at the north end of the quarry. This dike is from 10 to 15 cm. in width and occupies a straight walled fracture in the normal diabase which dips at a low angle, and is traceable for about 10 meters in the wall of the quarry. At its upper end the rock of this dike is coarse diabase pegmatite of dark color with large blades of diallagic augite, which are conspicuously developed normal to the walls, with broad cleavages of translucent greenish feldspar. Under the microscope this rock is found to consist, as usual, of large blades of perfectly fresh pyroxene of the ordinary purplish brown color, and crystals of clear plagioclase showing fine albite and pericline twin lamellae, with interstitial micropegmatite. The micropegmatite is sharp and its feldspar is all transparent and limpid with an index above that of the balsam. Iron ore occurs in the common skeletal form. All of the minerals are fresh and unaltered. In the field this rock can be clearly seen to pass by transition downward into a much lighter colored rock by decrease in the size and number of the pyroxenes and by the increase in the amount of a pinkish micropegmatite which is easily visible under a lens. A specimen from this dike halfway down the face shows central sharp crystals of feldspar which are largely sericitized but which, where unaltered, show the albite and pericline twin lamellae, have an index above that of the balsam and are apparently plagioclase like that of the rock above. These are surrounded by broad areas of micropegmatite, the feldspar of which is dusted with kaolin and has indices below that of the balsam and is doubtless albite. The augites of this specimen are partly changed to diopside, biotite, and hornblende, and the iron ore is to some extent replaced by titanite and secondary biotite. A specimen from the lower end of this dike is like the last in the lesser amount of dark minerals and in the predominance of the pinkish matrix. A section cut at the wall shows large plagioclase and purplish augite crystals and interstitial micropegmatite, in contact with the normal diabase. This grades outward into a rock made up of greatly kaolinized and sericitized feldspars and augite largely replaced by diopside. A section from the center of the dike here consists of albite crystals, muddy from the development of sericite and kaolin, with largely diopsidized augites, in an abundant matrix of quartz-albite micropegmatite.

The albitic rocks can easily be distinguished in the hand specimen after a little practice has been acquired, by the relatively lesser number and smaller size of the blades of pyroxene and by the white or pinkish color and more opaque appearance of the feldspar. The micropegmatite, when its amount becomes abundant, as in the albitic rocks, can be readily seen under a lens.

However the albitic rocks have been formed, the most noteworthy thing about the association of the two kinds of pegmatite is the fact that the feldspars vary abruptly from labradorite to practically pure albite without any intermediate members of the plagioclase series or any definite composition gradation. In the normal diabase pegmatite the micropegmatite is for the most part a quartz-labradorite intergrowth and this rock does not seem to contain any albite. An alkali feldspar occurs interstitially as micropegmatite but, judging from the analytic results as to potash, this seems to be entirely the potassium feldspar, orthoclase.

APLITIC ALBITE ROCKS.

White to pinkish sugary granular aplitic rocks occur occasionally as narrow persistent nearly vertical dikes averaging only about 3 cm. in width. These seem to follow the east-west fractures and intersect both diabase of normal grain and diabase pegmatite. They are usually though not invariably accompanied by more or less alteration of the adjacent rock, although this is not believed to have been due to the aplite as such, but rather to reopening of the fracture to permit the action of later solutions. One such dike showed absolutely no alteration of the adjacent diabase and, on the other hand, where the walls are altered the aplitic rock itself is affected by hydrothermal processes.

The aplites are variable in their amount of quartz and micropegmatite. The narrowest dike examined in thin section was about 6 mm. in uniform width. This was bordered on either side by an altered band of diabase 15 mm. wide which was probably altered after the aplite solidified by solutions moving along a later crack which intersects the zone, as the aplite is itself greatly altered. The aplite dikelet consists of muddy altered interlocking albite grains with abundant interstitial pale green spherulitic chlorite. Neither quartz nor micropegmatite was observed.

Another persistent dike was traced up the wall of the quarry for about 15 feet with an average width of about 2 cm. and intersected both diabase and diabase pegmatite. This also was found in thin section to be a granulitic aggregate of interlocking grains of albite, in this case with less quartz and with light colored transparent diopside. This dike, like the other, was intruded along a fissure which had later been reopened, and the aplite contained later seams filled with diopside and a little axinite, etc. Another typical aplitic dike is illustrated in contact with normal diabase in plate 2, upper. This is cut by later cracks of two periods, those of the first period being filled with diopside, while the latest crack, along which the specimen is broken, is coated with laumontite. Like many of the dikes this is porous from the presence of minute miarolitic cavities like those of the coarse albitic pegmatite, though much smaller.

The example of these aplites which was selected for analysis was a dike about 2 cm. in width which penetrated fresh and unaltered diabase. Under a lens this shows abundant albite and quartz with considerable pale green diopside and a few scattered crystals of titanite. It also contains a few grains of diopside full of inclusions surrounding nuclei consisting of short portions of blades of titaniferous diallagic augite, apparently fragments broken from the wall of the crack where it intersected a pegmatite mass, and arrested in process of alteration by the aplite magma. Under the microscope this rock shows a border made up of beautiful quartz-albite micropegmatite grown outward from the wall along with an occasional colorless prismatic crystal of diopside. The micropegmatite is well shown in the photomicrograph, plate 9, upper. The central portion of the narrow dike consists of a granular aggregate of albite with less quartz and some clear colorless diopside. All of the albite is muddy. The results obtained upon analysis of this rock are given in column 1 of the following table. In column 2 is given the analysis by Hillebrand of the holyokeite or "white trap" described by Emerson as fragments associated in an agglomerate above the main extrusive Triassic diabase of the Connecticut Valley in Massachusetts[9] and in column 3 is repeated the analysis by Washington of the thin acid dike described by Hovey[10] as keratophyre from Fair Haven, Connecticut.

Analysis of diabase aplite and related rocks.

Constituent.	1. Aplite Goose Creek, Va.	2. Holyokeite, Mt. Tom, Mass.	3. Keratophyre Fair Haven, Conn.
SiO_2	71. 60	53. 83	60. 13
Al_2O_3	13. 16	16. 36	20. 47
Fe_2O_3	1. 28	. 89	1. 04
FeO	. 38		. 72
MnO	. 03	Lost.	Trace.
MgO	2. 12	. 13	1. 15
CaO	3. 76	9. 81	2. 59
K_2O	. 70	1. 58	1. 06
Na_2O	5. 92	7. 89	9. 60
P_2O_5	Trace.	. 11	----------
TiO_2	. 34	. 86	Trace.
CO_2	None.	7. 47	3. 44
H_2O	None.	. 51	
S	----------	. 17	----------
Cu	----------	. 14	----------
Total	99. 29	99. 75	100. 20

[9] Benjamin K. Emerson. Holyokeite, a purely feldspathic diabase from the Trias of Massachusetts. Journ. Geol., vol.10, pp. 508-512, 1902.

[10] E. O. Hovey. Amer. Journ. Sci., vol. 3,1897, p. 287.

The norm calculated from the analysis of the Goose Creek aplitic dike, column 1 above, is as follows:

Norm of Goose Creek Triassic aplite.

Salic:	
Quartz	25. 98
Orthoclase	3. 89
Albite	49. 78
Anorthite	7. 51
Apatite	Trace
Total	87. 16
Femic:	
Magnetite	1. 39
Titanite	. 78
Hematite	. 32
Diopside	7. 99
Hypersthene	1. 60
Total	12. 08

This analysis, according to the quantitative classification, falls into class I, order 2, rang 2, subrang 5. The similarity of the composition of the rock to that of the albitic pegmatite is marked. It is obvious that the aplites are, like the albitic pegmatites, final products of a process of magmatic differentiation which yielded small amounts of a fluid acid residuum rich in water, this having been, in the case of the aplites, squeezed up narrow cracks in the solidified diabase. These rocks, as represented by the above analysis, are much more acid than any differentiate of the Triassic diabase yet described; this is shown by comparison with the two analyses quoted, which represent the most acid rocks previously known from the Newark series. These are likewise albitic rocks but lack the abundant quartz of the Goose Creek aplite.

So far as the magmatic processes are concerned in the production of the rock types here considered there are but three phases, first the normal diabase, second the diabase pegmatite, and third the albitic rocks. The normal diabase grades into the diabase pegmatite by gradual coarsening of grain but there seems to be a sharp break in composition between the diabase pegmatite and the highly acid albite rocks. The fourth product of the magmatic differentiation which need be mentioned here is probably water, charged with materials in solution, which doubtless produced all of the hydrothermal changes hereinafter considered.

Differentiation of this sort is not well exposed at many places in the Newark series and no example as extreme and striking as that at Goose Creek has heretofore been described in the rocks of this system. J. Volney Lewis, in considering the Palisade sill, has shown that the main mass of the rock is a somewhat quartzose diabase which has probably originated by gravitative differentiation through the

sinking of early olivine crystals which went to form a layer of olivine diabase near the bottom of the sill.[11] His discussion of the differentiation of this sill is very instructive and may well in large part be quoted, as follows:

Inasmuch as the several types of rocks described above occur as continuous portions of a single intrusive sill, they must be regarded together as constituting a unit. There is no evidence that they are products to any extent whatever of separate intrusions, or even of successive pulsations of an extended period of injection. Their present constitution and relations are best understood as the results of differentiation, or separation of the constituents of the molten magma after its intrusion and during the long period required for cooling and solidification.

The thickness of the sill or intrusive sheet varies considerably in its 100 miles of outcrop in New York and New Jersey, but it is everywhere several hundred feet thick, and in places, as along the Palisades above Weehawken, and in the thicker parts of Rocky Hill and Sourland Mountain, it approximates 1,000 feet. Under cover of a great blanket of overlying shales and sandstones, probably many times its own thickness at the time of intrusion, though since partly removed by erosion, this highly-heated molten magma cooled very slowly, and probably remained in a liquid condition for a considerable period. The only exceptions to this are the immediate contacts with the inclosing strata, which must have been quickly chilled; on the other hand, the adjacent shales and sandstones themselves became highly heated, and subsequent cooling was probably slow. The surrounding rocks are poor conductors of heat, and once a crust had formed, and the strata at the contact were well heated, the inclosed liquid mass became in a measure insulated. Under such conditions the outer crust of the magma would slowly thicken until the whole mass became solid.

Professor Iddings' conclusion that the process differentiation which gives rise to variations in the character of different parts of such a magma "must be of a chemico-physical nature; that is, a chemical process resulting from varying physical conditions, especially temperatures," is doubtless true in most cases and probably to some extent in all, but in the present state of our knowledge, it seems scarcely justifiable to exclude entirely the possibility of purely physical processes acting alone. This applies particularly to the settling of heavier crystals in the more basic magmas, which are highly fluid, and might well remain so long enough for such a process to produce considerable effect. In fact, the extent of such gravitation of the heavier minerals may be regarded as a measure of the degree and duration of the liquidity after the beginning of crystallization, and the absence of such effects only as evidence that the particular magma has become too viscous to permit effective differentiation from this cause.

Further, the time of crystallization of a particular mineral is held to have some definite relation to its concentration in the solution, and this seems to imply that the definite molecular group exists as the point of saturation is approached, ready to crystallize when that point is reached. In acid magmas the proportion of basic constituents is small, and saturation would occur only at a correspondingly lower temperature than in those basaltic magmas which carry basic substances in large amounts. Hence the crystallization of magnetite and augite in rhyolite, for example, would probably not take place before the whole magma has cooled to a highly viscous condition, particularly as this condition

[11] J. Volney Lewis. Petrography of the Newark igneous rocks of New Jersey, Ann. Rept. State Geologist N. J. for 1907, pp. 129-133.

would occur at a comparatively early stage of cooling in the more difficultly fusible siliceous solvent.

The basaltic magma, on the other hand, with its low melting point and its high content of dissolved basic constituents, would reach the point of saturation for some of these (magnetite and olivine, for instance) at comparatively high temperatures and while the lava is still quite fluid. If such minerals crystallize any considerable length of time before the other constituents, the magma remaining liquid, their concentration in the lower parts of the mass by gravitation must result as a mechanical necessity, unless there are eddies or other currents sufficiently strong to prevent; and such currents would probably prevent differentiation by any process in the parts affected. In many rocks the ore grains are much smaller than the silicate minerals, and would therefore offer greater resistance to settling through the magma. In such cases gravitation would affect the larger olivines particularly.

In the next stage of crystallization, there would undoubtedly be the same tendency for the augite crystals to sink and the feldspars to rise toward the top of the sheet, but by this time the increasing viscosity of the magma and the clouds of new minerals forming would doubtless prevent any extensive segregation of these by gravitation.

The degree of concentration finally attained by this process would depend on the fluidity of the magma and the time intervening between the formation of the first minerals and the next succeeding stages of crystallization. Further, the position reached by such descending minerals would be determined by the viscosity of the magma toward its lower contact, that is, by the extent of cooling due to the rocks into which it was intruded.

The basic concentration forming the olivine-diabase ledge in the Palisades was not formed at the cooler contact, nor is it duplicated in the corresponding upper portions of the sill. Its formation can not, therefore, be attributed to the action of Soret's principle or any other process of concentration due to cooling. If regarded as the result of chemical differentiation before intrusion, it must be an earlier or later injection than the accompanying diabase above and below, but its uniformly coarse texture and its great regularity in thickness and position with reference to the base of the sill would seem to preclude this hypothesis. The great overlying body of diabase, however, has been entirely freed from olivine, except at the upper contact, and this mineral has been lodged in the remarkably distinct zone of olivine-diabase 10 to 20 feet in thickness and lying 40 to 50 feet above the base of the sill. The bulk of the diabase, however, is somewhat quartzose, but it often passes into normal diabase, and toward the contacts into a somewhat olivinic facies, which is more basic in character, though much less so than the diabase ledge referred to above.

The above is the only detailed discussion of differentiation of the diabasic magma occupying sills in the Newark series known to the writer, and is quoted because of the similiarity of the Palisade sill to that of Goose Creek and because it forms an excellent exposition of the principle of gravitative differentiation to serve as a background for other quotations.

As compared with the above hypothesis of purely gravitative processes operating in a sill chamber of molten magma is the explanation of Daly [12] of the Moyie sills of British Columbia, where large sills of

[12] R. A. Daly, Geol. of the N. A. cordillera at the 49th Parallel, Mem. 38, Can. Geol. Surv., pp. 226-256, 1912.

gabbro intrusive into quartzite have an uppermost layer of biotite granite. These are regarded as having originated from the fusion and assimilation of the intruded quartzite.

The view adopted includes what has been called the assimilation-differentiation theory. The acid zone is thereby conceived as due to the digestion and assimilation of the acid sediments, together with the segregation of most of the assimilated material along the upper contact.

This theory of differentiation has since been greatly amplified by the same author.[13] It is interesting to quote the objection of Lewis[14] to its application to the Palisade sill.

A hypothesis of stoping or splitting off and engulfing slabs of overlying strata, afterwards assimilated by solution in the magma, has been invoked instead of some process of differentiation in explanation of certain facies eruptive rocks. In case of the Palisade diabase, however, as in some cases at least to which this theory has been applied, the process would seem to be mechanically impossible on any important scale. The diabase is 20 per cent heavier than the inclosing strata, and unless this was more than offset by expansion in the fused mass, it would be impossible for sandstone or shale to sink into it, even if completely broken away from the parent stratum. If stoping is possible at all in such cases it must be underhand stoping, which the advocates of the hypothesis have not yet claimed.

The Gowganda Lake sills described by Bowen[15] present some very close analogies with the Goose Creek area, as may be seen from the following quotations:

The sills * * * are not always entirely composed of the dark gray diabase. In places we often see little pink spots, found to be areas of micropegmatic (quartz and albite). This material may increase in amount until it forms quite the whole of the rock, giving rise to "red rocks" or granophyres. Moreover, pink aplitic veins are often numerous in the sills. To the development of these "red rocks" and their relations to the diabase and inclosing sediments attention will now be given. The sills almost uniformly show the albitic rocks at or near their upper contacts. Summing up the evidence of the upper contacts of the sills, just described, we have at the Foot Lake sill, in one place, the special development of granophyric material in the diabase quite close to its contact with altered slate or adinole, the granophyric interstices having practically the same composition as the adinole and evidently derived from the latter by some process of transfusion. A little farther south where the action has been more intense a wider zone of adinole developed. Part of the adinole close to the diabase has been to some extent recrystallized, giving the beginning of granophyric structure. The writer believes that in the case of the Lily Lake and Lost Lake sills the evidence points to a still more complete recrystallization of part of the adinole with the production of typical granophyre. In other words, some of the adinole was essentially in a state of aqueous fusion and crystallized as granophyre. The melt thus formed was to a certain extent free to diffuse into the diabase magma and gave rise to the abundant granophyre interstices near the granophyre.

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[13] Igneous Rocks and their origin. New York, 1914.

[14] Petrography of the Newark Igneous Rocks of New Jersey, p. 132.

[15] Journ. Geol., vol. 18, pp. 667–69, 1910.

If we inquire into the conditions of the formation of adinole from slates, we will find that wholesale introduction of albite as such is not necessary. Some magnesia, iron, and alumina are lost by the sediment. Silica has probably not been introduced, for the loss of the above-mentioned constituents suffices to increase the silica to the percentage in adinole. Finally potash, too, is lost and at the same time is replaced by soda. Carbonate waters, bearing a little soda, could accomplish the work necessary. That such waters exist in basaltic magmas and have important effects during the late stages of crystallization is the conclusion of Bailey and Grabham in a late article. If the conclusions of the present writer are correct, such waters, emanating from the diabase, have produced the adinole and the adinole-rich granophyre here described. The waters supplied most of the soda and the sediment supplied alumina and silica. Calcite is an almost universal constituent of the aplite veins associated with the granophyres. It has in some cases apparently crystallized together with the aplite minerals. This certainly points to the presence of carbonated waters. * * * That the granophyre "solution," formed as here imagined, was foreign to the diabase magma is indicated by the intense alteration of the constituents of the diabase near the granophyric interstices.

The aplitic veins (quartz and albite, often with calcite) which cut both granophyre and diabase, were formed from the more acid residuum of the granophyre. They are especially numerous near a mass of granophyre. The extreme purity of the albite * * * points to their aqueous origin, as does also their calcite content. This aqueous residuum probably deposited also the valuable metallic content of the aplite veins and of the associated calcite veins.

Another much studied example of the association of very basic gabbroic rocks, with acid differentiates contrasting markedly in composition, is the Duluth gabbro mass with its associated "red rocks," which are largely composed of quartz-feldspar micropegmatite. The gabbro itself has formed numerous varieties by some modification of the process of gravitative differentiation. The red rocks have been carefully described by Grout,[16] from whose paper the following abstract is taken:

The gray gabbro rapidly gives place to a bright red rock very different from the gabbro in mineral, chemical, and physical characters. * * *

The chief outcrops near Duluth are irregular patches at the top of the main gabbro and apophyses into its roof; it occurs also near the top of the earlier feldspathic gabbro, in a large sill close above the gabbro, and in some small dikes near the bottom of the gabbro.

The texture varies from sugary near contacts to very coarse in certain patches. The rock is peculiarly friable, so that hand specimens can hardly be trimmed from it. A striking local variation contains long needles of dark minerals in a red matrix. In thin sections it is micropegmatitic, varying to granitoid in some large masses. Miarolitic cavities are numerous in some places. Variability is as characteristic of the minerals as of the textures. The chief red mineral is a feldspar stained with considerable hematite and badly kaolinized. Probably most red rock contains two feldspars; zoning is especially common in the phases grading into the gabbro. Quartz, though abundant, is rarely visible except with the microscope as an intergrowth. Hornblende is the chief ferromagnesian

[16] Frank F. Grout. A type of igneous differentiation. Journ. Geol., vol. 26, pp. 632–634, 1918.

mineral, but it is fibrous and mixed with secondary minerals as though itself secondary. Biotite is rare and in most cases secondary. * * *

Possibly (the name) granophyre is appropriate for most of the rock.

In the sill in the eastern part of the city there is a remarkable example of perfect gradation from diabase to red rock. The diabase is of ordinary type, with a finer contact phase at the base. It is exposed almost continuously for a width of a mile, equivalent to a thickness of several hundred feet. The diabase grades up into a red-rock zone of smaller thickness and less regularity, though a belt may be followed for several blocks. It is noteworthy that while the sill must be nearly 1,500 feet thick, the conspicuous gradation zone is less than 50 feet thick, from black diabase to intensely red granophyre.

A somewhat different gradation is observed in Lincoln Park and near the top of the inclined railroad to Duluth Heights. In these places it is possible to select samples showing all stages between gabbro and red rock, but the relations are not those of a regular zone. The upper part of the banded gabbro shows many local patches with interstitial red granophyre, grading into dike like stringers and patches of red rock of complex form and relations. Many of these stringers with sharply defined walls can be traced along their length into less sharply defined markings and finally grade imperceptibly into the black gabbro which formed the walls a few feet away. Both the gabbro and the red rock intrude the roof, sometimes in the same crack, sometimes more distinctly. Although a considerable part of the red rock is so much later in time of solidification that it could intrude the gabbro, the texture of the red rock is coarse up to its contacts and grades into that of the gabbro without a break, indicating that they were about equally hot. The irregularity in form of the stringers may also be a sign that the gabbro was not wholly solid. Such a relation may be described as that of an aplite.

Similar relations of gabbro to red rock, both gradational and aplitic, are easily traced for many miles along the belt at the northeast end of the gabbro in Cook County, where the combined thickness is so reduced as to make the mass more like a sill, and the red rock constitutes a larger portion of the intrusion than at Duluth. The same relation may be expected in the central, thicker part of the gabbro mass, but this has not been mapped in detail as yet.

A third gradation from red rock to gabbro is that in the pegmatites near the base.

All three of these occurrences of red rock and gradations would seem from field studies to be clearly attributable to a differentiation * * *. The several occurrences may all be explained by supposing that the original magma contained some vapors under pressure and that these tended to separate and escape from the main magma bearing with them those acid and alkaline constituents for which they seem to have a special affinity. The accumulation of a definite upper zone of red rock would then be the result of a quiet rise of the lighter vaporous separate under an impervious roof. The aplitic areas near the top would be similar gravitative separates, disturbed by some movements at about the time of solidification. The pegmatites and aplites below would be located not so much by gravity as by simple vaporous tension; the lighter separate, being more fluid, might penetrate cracks on any side of the magma chamber in advance of the main magma.

Bowen[17] has discussed the crystallization of basaltic magmas with especial reference to the frequent association of diabase and grano-

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[17] Norman L. Bowen. The later stages of the evolution of the igneous rocks. Journ. Geol., Supplement to vol. 23, 1915.

phyre. He takes it as the starting point for a discussion of the physical chemistry of silicates with the following introduction:

Diabases with micropegmatite interstices are very common. Sometimes the micropegmatite (granophyre) is separated as a distinct body, a granite, granodiorite, or quartz diorite in composition. This association is of fundamental importance in petrogenic theory and will be made the starting point for a discussion of the geologic evidence supporting crystallization differentiation. It is, in many cases, clearly shown that when the diabasic (basaltic) magma was intruded as a small body and was therefore quickly chilled, it crystallized as a normal plagioclase-pyroxene diabase without quartz. On the other hand, large bodies usually show micropegmatitic interstices and often a similar salic differentiate. This contrast between the larger and smaller bodies has led some petrologists to the opinion that the more slowly cooled, large bodies has an opportunity denied the quickly cooled bodies—the opportunity to assimilate siliceous material, whence the siliceous differentiate. Direct evidence of adequate assimilation is seldom if ever clear; its accomplishment is nearly always inferred from the existence of the acid differentiate. * * *

Following a discussion of the equilibrium relations of the several rock forming silicates, in the light of the results obtained from the investigations of various systems, the following conclusions are attained:

Crystallization with zoning.—When the cooling is too rapid to give crystallization of the perfect equilibrium type and yet not rapid enough to give the great degree of undercooling referred to in the foregoing, the formation of zoned crystals of plagioclase will result. According as one or the other of the above-named rates of cooling is approached the degree of zoning is reduced to a minimum. With a certain intermediate rate of cooling maximal zoning results. In this case, a crystal once separated suffers thereafter no change of composition, the liquid disregarding crystals which have already formed, so that the crystallization of the liquid may be regarded as beginning anew each instant.

The effect of this action may be realized by considering that during the crystallization of the liquid F, as already outlined, the liquid portion is separated from the crystalline portion at a temperature of, say, 1,220°. At this temperature the liquid has the composition K and we shall imagine that this separated liquid is crystallized under perfect equilibrium conditions. Instead of becoming completely crystalline at 1,200°, as it would if the crystals had not been removed, it now becomes completely crystalline only at 1,178°, and the final liquid, instead of the composition M, has the composition S; i. e., is much richer in albite. If the virtual separation of liquid from crystals is a continuous process accomplished through the intervention of zoning, it is plain that the offsetting in the composition of the final liquid is limited only by the eutectic albite-diopside which it actually attains in the case of maximal zoning. This fact is true, not only of the special liquids to which reference has been made, but of any mixture of anorthite, albite, and diopside whatsoever.

* * * The sinking of crystals of plagioclase in a mass of liquid which is very slowly cooled will obviously affect the upper layers from which the crystals have settled in the same manner that zoning affects the residual liquid. * * *

* * * When the liquid is very quickly cooled it crystallizes quickly, if at all, and with little or no tendency to an offsetting in the composition of the liquid. If it is cooled moderately slowly, zoning of the plagioclase causes a

continual enrichment of the residual (interstitial) liquid in albite. If it is cooled still more slowly, sinking of plagioclases causes a similar continual enrichment of the residual (upper) liquid in albite. In favorable cases the final liquid may be more than 90 per cent albite even although the original mixture were, say, 50 per cent diopside and 50 per cent bytownite.

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If we now combine the information furnished by the investigated systems, important conclusions may be drawn with regard to the crystallization of basaltic magma under various conditions. Instead of the simple pyroxene, diopside, present in the mixtures of the last system discussed, we may consider one of the intermediate pyroxenes, which melt with decomposition and the formation of olivine, to be present in addition to plagioclase. Rapid cooling of such a liquid would give merely plagioclase and pyroxene. On the other hand, slow cooling permits radical variation from this simple result. The early formation of olivine brings about an excess of free silica in the residual liquid if any process intervenes to prevent the resorption of olivine by the liquid. The early formation of very calcic plagioclase brings about an enrichment of the liquid in albite if anything intervenes to prevent the continual alteration in the composition of the crystals by interchange with the liquid. Finally the early formation of magnesia-rich pyroxene brings about an enrichment of the liquid in diopsidic pyroxene if similar conditions intervene.

The sinking of crystals affords a means of continually separating crystals from the part of the liquid in which they formed and is therefore a process which will give the results just outlined. If, therefore, the mixture of plagioclase and pyroxene referred to were cooled slowly and continual sinking of crystals occurred, the inevitable result would be a body consisting of calcic plagioclase, olivine, and magnesian pyroxene in its lower parts (i. e., of a gabbroidal nature) and of sodic plagioclase approaching albite, diopsidic pyroxene, and free silica in its upper parts (i. e., of a granitic nature), with various intermediate types in the intermediate layers. If the freedom of sinking of crystals were somewhat restricted, one of these intermediate types, say a granodiorite or a diorite, would occur as the uppermost differentiate, the limit of the process under these less favorable conditions. The composition of the residual liquid might, moreover have been similarly affected by zoning of the crystals even if there were no opportunity for the sinking of crystals, and in this case the *interstitial* material of late crystallization would be the same salic material as that found in the upper layers where sinking of crystals took place. If a certain amount of both zoning and sinking of crystals took place, a body would result showing the salic differentiate both as interstitial material and as a separate upper layer. * * *

It has been possible, then, to deduce from facts ascertained experimentally the crystallization with quick and slow cooling of mixtures which give results closely analogous to the occurrence observed in nature of diabase in small dikes and small sills (quickly cooled) and of diabase with micropegmatite interstices or a granitic or granodioritic differentiate in larger bodies (slowly cooled). There are many differences and complications in the natural magma in the matter of details, but it is clear that the broad scheme is well understood and that crystallization is the sole control. There is no necessity for assuming that assimilation of siliceous material is essential to the formation of the salic differentiate, nor that its separation is accomplished by the process of liquid immiscibility.

It is necessary to consider all of the examples of differentiation above described and the several explanations advanced to account

for the phenomena, in their relation to the phenomena observed in the diabase at the Goose Creek quarry.

The quarry is located practically at the base of a large intrusive tabular mass of diabase, probably a sill or a very flat dike, some hundreds of meters thick. Such a mass should be expected to differentiate with the sinking of crystals, provided that cooling did not take place too quickly. At the base, however, the heavier and more basic minerals should be concentrated by this process, giving gabbroic rocks, while higher in the sill the more acid differentiates should be found, particularly at or near the roof. There is, however, no evidence of any banded structure in the diabase, nor any increased basicity toward the bottom, and the rock to the very bottom of the mass, exclusive of a possible chilled border phase, seems to be representative of the average of the mass. It is a diabase not in any wise different from the undifferentiated basaltic rocks of the Newark series, as shown by the comparison of analyses above. Although observed occasionally, micropegmatitic interstices are not a conspicuous feature of the rock, and the plagioclase is almost free from zoning. It is concluded from these facts that this diabase mass as a whole cooled too quickly to give the differentiation effects obtained upon slow cooling of diabasic magma and consequently crystallized simply as a mixture of basic pyroxene and plagioclase.

The differentiates, ranging from rock only slightly different from the normal diabase in composition to pure albite-quartz rock, are another matter. These occur near the bottom of the sill instead of at the top so that they can not have originated by the sinking of crystals, and they occur as numerous more or less insolated bodies of small size.[18] These likewise can not be explained by the syntexis or solution of engulfed blocks of the intruded rock unless they are local syntetic bodies of material which has risen from the floor of the sill through the diabase or blocks from the roof which have sunk through the magma in the chamber to the bottom, there to be dissolved. Neither of these possibilities has any concrete support and the latter possibility seems precluded, as suggested by Lewis, by the fact that blocks of shale or limestone would float on the molten basalt. It is possible that the solution of the shale or limestone in the magma would yield the effects obtained but there is no evidence to support such a contention. Such an explanation of the origin of the granophyres of the Gowganda Lake region, first favored by Bowen, as quoted above, has since been abandoned by him:[19]

Somewhat similar sills in the Gowganda Lake district of Ontario, described by the writer, have essentially the same relations. In the original paper it was

[18] It is of course possible that other similar differentiates occur near the top of the diabase sill but no exposures favorable for study are available.

[19] Norman L. Bowen. Later Stages of Evolution, etc. Journ. Geol., vol. 2, appendix, p .49, 1915.

considered that the surrounding ssdiments played an important part in the formation of granophyric bodies at the upper surface of the sills. This opinion was arrived at principally because of the difficulty of picturing any process of pure differentiation whereby a quartzose rock could be formed from basaltic magma. With this difficulty removed the writer has no hesitation in concluding that the granophyre and the micropegmatite interstices of the diabase were formed after the manner detailed in the present paper and that interchange of material between the granophyre and adinolized sediment was a subsidiary process contributing to the soda-rich nature of the border phases.

There is no support, in the relation of the later differentiated types of material at Goose Creek, of the theory of immiscible separation of liquids in the magma. On the contrary, the clearly intrusive relationship of the later rocks in many cases shows that the surrounding diabase must have been almost completely crystallized although it unquestionably was at an elevated temperature and quite probably was more or less pasty rather than rigidly solid. It is clear that the masses of diabase pegmatite, albitic pegmatite, and quartz albite rock are the result of a differentiative process which took place, locally, in a magma chamber wherein the magma, as a whole, cooled and crystallized too rapidly to permit of general differentiation. Obviously some special factor was active in the control of events and it is pertinent to inquire into the nature of this factor.

The most strikingly conspicuous feature of these unusual rocks is their extremely coarse texture, and it has been stated above and substantiated by quotations, that the most probable cause of this coarsening was water (or other volatile constituents) of the magma. It is noteworthy that in a great majority of the described examples wherein extremely alkalic differentiates have resulted from diabasic magma, especially in smaller masses where, as here, the main sill mass shows little evidence of differentiation with settling of crystals or conspicuous zoning, the same sill contains abundant evidence of the presence of more than ordinary amounts of volatile material, notably water, as indicated by masses and dikes showing extremely coarse textures and by intense hydrothermal alteration of the rock immediately following their consolidation. Thus in the Gowganda Lake region there are examples of extreme coarsening of grain in the diabase and of intense adinolization of the enclosing rock at the contact. In the Duluth gabbro the coarse structures are conspicuous while the red rock is characterized by a porous texture and kaolinization of the feldspar and uralitization of the ferromagnesian minerals. It seems that differentiation resulting in moderate amounts of silicic rocks is greatly faciliated by a richness of the magma in dissolved water. The source of this water is problematic. It may have been original in the magma when it was intended or it may have been subsequently derived in considerable part from the intruded rocks.

The diabases of the Newark series were rather variable in the amount of water which they contained, as indicated by the textures of the consolidated rocks and the hydrothermal effects produced. Shales are highly hydrated rocks, and the most conspicuous feature of the shales adjacent to the intrusive, both at Goose Creek and elsewhere, is a loss of the shaly structure and a compacting and hardening doubtless due to loss of water. A body of molten magma of diabasic composition, surrounded on all sides by hydrous shales, would certainly tend to increase its content of dissolved water by solution of the highly heated water of the adjacent shales. In sandstones there would be less necessity for the water to dissolve in the magma since it would be more free to move outward from the heated zone. This may explain the greater frequency of the occurrence of differentiation and other aqueous effects in sills in shales than in those in sandstone or in relatively anhydrous rocks. That water can dissolve in molten silicates under pressure has recently been shown conclusively by Morey.[20] The presence of this water introduces complications into consideration of the problem of crystallization. Whereas in a simple silicate melt all of the constituents can enter into the consolidated product, without regard to the rate at which cooling took place, water or other volatile constituents of the melt will be expelled by crystallization of anhydrous minerals and must of necessity concentrate in the still fluid portions of the magma, resulting in an increase of pressure and a lowering of final consolidating temperature. If the magma crystallizes from the early cooled walls inward there must be a concentric inward expulsion of the water, which in the ideal case would result in a centrally placed pegmatite. Actually this happens in dikes and in some thin or small intrusions, where it is easily demonstable. In larger intrusive masses, however, the volatile constituents seem to concentrate in centers whose location is determined by some unknown factor. Differential movements might result in local areas of lessened pressures and here gases would tend to concentrate and pegmatites might form. These may occur thickly scattered in groups or widely spaced singly in the mass of the rock, and they are well exhibited by coarse and pegmatitic areas, which are common features not only in the gabbroic and diabasic rocks but especially in many areas of granitic rocks. Typical of such "pegmatite chambers" are the pegmatites of the Quincy granites as described by Warren and Palache.[21]

The mechanism of this concentration of volatile materials in residual magma chambers can not at present be delineated. It is, how-

[20] George W. Morey. The development of pressure in magmas as a result of crystallization. Journ. Wash. Acad. Sci., vol. 12, p. 219, 1922.

[21] Charles H. Warren and Charles Palache. The pegmatites of the riebeckite-aegirite granite of Quincy. Mass., U. S. A.; their structure, minerals, and origin. Proc. Amer. Acad. Arts and Sciences, vol. 47, pp. 146-147, 1911.

ever, a variant of crystallization-differentiation and can not be considered to be liquid immiscibility. Such volatile constituents would doubtless carry with them constituents of the magma from which they were expelled, principally silica and alkalies, especially soda, and the residual mineralizer-rich magma is probably always enriched in material thus derived. The diabase pegmatites of the Goose Creek locality are of this nature. Whereas the main body of the diabase cooled too rapidly to be greatly differentiated, these small chambers, having high molecular mobility due to dissolved gases with lowered consolidating temperature and under greatly increased pressure, had an opportunity to crystallize more slowly with the production of very large crystals. The minerals which crystallized out of these melts were at first and in greatest amount the same as those which were formed in the normal diabase, namely iron and titanium rich augite and moderately calcic plagioclase. These grew outward from the walls of the relatively small chambers and apparently left a central residuum of liquid out of which subsequently crystallized albite and diopside, leaving a final interstitial liquid which formed quartz-albite micropegmatite. The process was interrupted at various stages by strains which ruptured the consolidated surrounding diabase and carried the liquid, at whatever stage, out as a dikelike mass into the crack. Zoned crystals of the augite surrounded by diopside and of calcic plagioclase surrounded by albite occur but are not common. The most difficult feature to explain is the hiatus between the crystallization of the augite and labradorite of what is called normal diabase pegmatite and the relatively pure albite with diopside and abundant quartz which form what has been described as albitic pegmatite and aplite. Apparently the liquid attained its final very salic composition solely by the crystallizing of relatively basic minerals. It behaved as though the quartz-albite mineralizer magma were a solute and the basic plagioclase, magnetite, and augite were dissolved materials which were influenced in their crystallization from solution by the molecular attraction of the same minerals in the adjacent diabase. The final acid fluid was not stable in contact with these minerals at the close of the magmatic phase as shown by the evident reaction between the crystals and the residuum, with replacement of plagioclase by albite, of augite by diopside, and of magnetite by titanite. This rarely if ever reached equilibrium, however, probably because fissuring of the mass of the diabase was going forward and the release of the pressure of the dissolved gases, which must have been enormous in the later stages, and upon which the fluid depended for its lowered crystallization temperature, caused complete consolidation and release of the volatile constituents. These constituents carried with them a load of dissolved solids and continued to react in the same manner upon whatever material they were in contact with, replacing plagio-

clase by albite, augite by diopside, and magnetite by titanite. It is consequently difficult to definitely separate magmatic from hydrothermal action.

The process is clearly a special phase of crystallization differentiation, which may be termed "pegmatitic differentiation," and presents certain peculiarities depending upon the abundant presence of volatile constituents in the magma system. While there are certain hiatuses in the normal sequence which can not now be explained, it is important that the processes are essentially the same as those outlined by Bowen in his discussion based upon the investigation of anhydrous systems. It is probable that the differentiation of any natural magma is speeded up and that the reactions are facilitated by the presence of volatile constituents.

The behavior of the water released after crystallization of the final magmatic product is further discussed below.

MIAROLITIC CAVITIES.

Under the term "miarolitic cavities" are comprised small open spaces which occur in the coarser albitic rocks and are lined with quartz and albite crystals. In most cases in the rocks rich in micropegmatite these cavities are at the junction of several areas of micropegmatite, and the albite and quartz crystals on the walls are as a rule continuous with the same minerals of the adjacent rock and have only formed euhedral crystals because of space being available for development. Entirely similar cavities occur also in coarse albite rocks considered as possibly having originated through hydrothermal alteration of normal plagioclase-pegmatite.

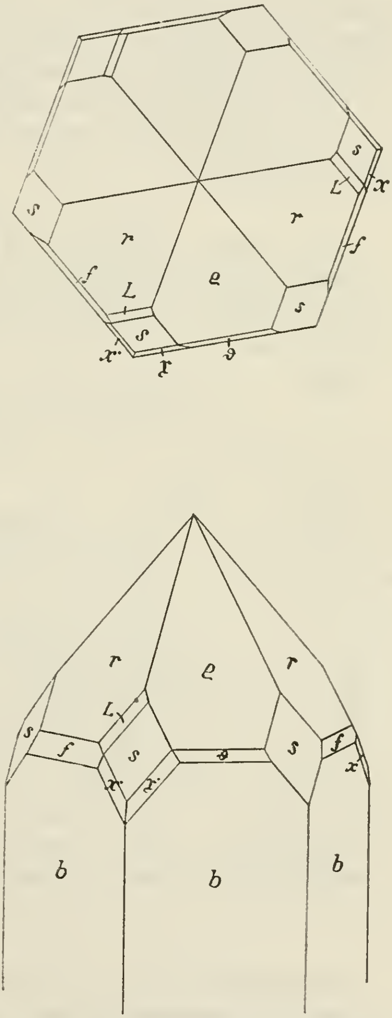


FIG. 2—QUARTZ—SHOWING HIGHLY MODIFIED DEVELOPMENT OF QUARTZ CRYSTALS OCCURRING IN MIAROLITIC CAVITIES.

The minerals of these cavities have been referred to as: First generation, those which are the constituents of the surrounding rock and seem to have only accidentally abutted against the cavity, namely, albite, quartz, diopside, and titanite; and second generation, which are considered to have been deposited on the others by hydrothermal solutions, namely, epidote, fibrous hornblende, chalcopyrite, and chlorite. In one thin section, however, typical fibrous hornblende was seen incorporated in an albite crystal which was itself a later product than the albite of the adjacent rock.

The cavities vary from very minute or microscopic to some which are 3 cm. across. The minerals in them may be described individually as follows:

QUARTZ.

The quartz is in the form of transparent slightly smoky crystals interspersed with the albite crystals. These reach a length of 2 mm. and are rather rich in faces. One such which was measured had the development shown in figure 2 and gave the following forms and angles:

Forms and angles of quartz fron a miarolitic cavity.

Form.		Symbol.		Quality description.	Measured.				Calculated.			
No.	Letter.	Gdt.	Miller.		φ		ρ		φ		ρ	
					°	′	°	′	°	′	°	′
1	b	$\infty 0$	$10\bar{1}0$	Excellent	0	05	90	00	00	00	90	00
2	r, ϵ	± 10	$10\bar{1}1$	Good	0	05	51	37	0	00	51	47
3	σ	$-\frac{2}{3}0$	$30\bar{3}2$	Poor	0	40	62	11	0	00	62	18
4	f	$+40$	$40\bar{4}1$	Vero good	0	00	78	54	0	00	78	52
5	s	$+1$	$11\bar{2}1$	Good	29	57	65	29	30	00	65	33
6	$x^{\cdot}$	$+51$	$51\bar{6}1$	do	8	55	81	56	8	57	81	57
7	$L^{\cdot}$	$+1\frac{2}{3}$	$32\bar{5}3$	do	23	16	61	25	23	25	61	33

In their development some of the forms do not agree with the ymmetry of the class, a discrepancy doubtless due to twinning.

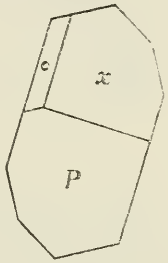
ALBITE.

The albite, which is the most abundant mineral in the cavities, occurs in crystals which reach an extreme diameter of about 4 millimeters. They vary from opaque to transparent and from white to pale pinkish. They all have the relatively simple form shown in figure 3. One which was measured on the 2-circle goniometer gave the following angles:

Forms and angles of albite from miarolitic cavity.

Form.		Symbol.		Quality description.	Measured.				Calculated.			
					φ		ρ		φ		ρ	
No.	Letter.	Gdt.	Miller.		°	′	°	′	°	′	°	′
1	T	∞	110	Poor	61	21	90	09	60	30	90	00
2	l	$\infty\bar{\infty}$	$1\bar{1}0$	Excellent	120	26	90	09	119	52	90	00
3	B	0	001	Fair	82	20	27	12	81	51	27	01
4	z	$\infty\bar{3}$	$1\bar{3}0$	Good	150	38	90	00	149	44	90	00
5	o	$\bar{1}\bar{1}$	$\bar{1}\bar{1}1$	Medium	$\bar{1}35$	12	34	10	$\bar{1}35$	21	34	11
6	x	$\bar{1}0$	$\bar{1}01$	No reflection. Identified by zonal position.								

The crystals tend to aggregate in parallel position. They are twinned on the albite law. On many of them the twinning is not conspicuous under a lens as the laminae in reverse position are very thin, but a few are composed of two individuals, each of them complete, united in alternate positions on the (010) face.



When these crystals are crushed and examined under the microscope they are found to be clear and transparent with a mean refractive index of 1.530 to 1.531, indicating a nearly pure albite.

DIOPSIDE.

Diopside, which is absent from many of the cavities, abuts against some as though by accident of position. In a few, usually in altered albitic pegmatite, it forms well developed transparent bottle green crystals which are evidently deposits in the cavity rather than diopsides of the surrounding rock which have chanced to abut against the cavity. Many of the diopsides have a terminal outgrowth of silky fibers of hornblende in parallel position or as loosely attached tufts and the cavity containing the largest and best diopside crystals had its central portion completely filled with a matted aggregate of the silky hornblende. A crystal from this cavity, 3 mm. by 7 mm. in size, was measured, yielding the following measurements:

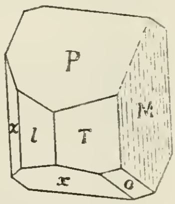


FIG. 3.—ALBITE—SHOWING COMMON HABIT OF ALBITE CRYSTALS OCCURRING IN MIAROLITIC CAVITIES.

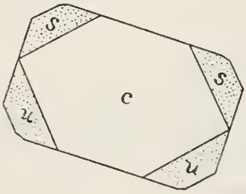
Forms and angles of diopside crystal from miarolitic cavity.

Form.		Symbol.		Quality description.	Measured.				Calculated.			
					φ		ρ		φ		ρ	
No.	Letter.	Gdt.	Miller.		°	′	°	′	°	′	°	′
1	a	∞0	100	Poor, striated	90	30	90	00	90	00	90	00
2	b	0∞	010	Poor	0	06	90	00	0	00	90	00
3	m	∞	110	Very good	42	40	90	00	43	33	90	00
4	f	3∞	310	Medium narrow.	70	21	90	00	70	41	90	00
5	c	0	001	Fair, etched	90	21	15	30	90	00	15	51

The habit of these crystals is shown in the drawing, figure 4. The faces shown as *u* (111) and *s* (111) are entirely dull and their identity was inferred from their zonal positions. Under the microscope the powder of the diopside crystals was found to be colorless and transparent. It is biaxial positive (+) with 2V medium large, the refractive indices being $\alpha = 1.672$, $\beta = 1.682$, $\gamma = 1.702$. The dispersion is perceptible, $r > v$.

TITANITE.

Titanite is a common constituent of the rock which surrounds the miarolitic cavities and quite frequently a crystal abuts against a cavity. No crystals of this mineral were seen which were clearly later deposits in a cavity. The crystals are of the usual resin-yellow color and have the familiar envelope habit. They are not better crystallized against the open space than in the adjacent rock.



HORNBLENDE.

Hornblende is a widely distributed mineral in the cavities although its amount varies greatly. It is all an asbestiform (byssolitic) variety which is usually in masses of cottony snowy fibers although the color occasionally varies to pale buff or light green. Most of the cavities have only a minute wisp of the fibers but the largest cavity seen, from which the measured diopside crystal was taken, was packed full of the cottony hornblende. The hornblende is a "second generation" mineral in the cavities. The first wisp of fibers in the smaller cavities does not seem to replace anything, although where the action of the solutions in the surrounding rock was more extensive the diopsides are replaced by fluffy masses of the hornblende fibers, and the materials of all the cavity-filling hornblende may be derived from the diopside of the adjacent rock. Such fine fibrous hornblende is widespread in distribution and was seen, in thin sections, inclosed in calcite, in parallel growth on chlorite, and inclosed in later albite crystals.

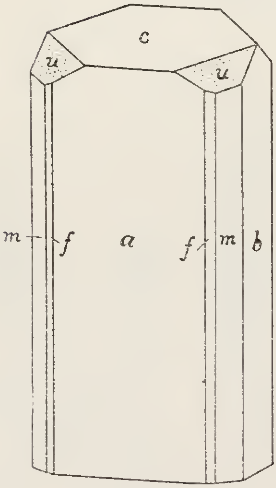


Fig. 4—Diopside; prismatic crystal from miarolitic cavity.

Under the microscope the thicker bundles of the very fine fibers, although very pale, are seen to have some color and pleochroism, being blue-green parallel to the elongation and brownish-green across the elongation. The thinner fibers are colorless and transparent with positive elongation and an average maximum extinction, $Z \wedge \dot{c}$,

of about 16° or 17°. The index varies slightly but the range of the mean index is between 1.65 and 1.67 indicating a rather high iron content. This hornblende is the same, essentially, as that occurring in the zeolite-bearing veins which is described in somewhat greater detail below.

CHALCOPYRITE.

Chalcopyrite is of rather frequent occurrence in the cavities as single crystals which are too striated to yield good measurements. These reach a maximum diameter of about 3 mm. and are later than the quartz and albite crystals of the lining of the cavities. In the altered rock the chalcopyrite is often more or less decomposed on the outside and along cracks to a dark brown to black material of brilliant pitchy luster. This alteration product under the microscope is transparent, golden-brown and completely isotropic, and has an index well above 1.82. It is doubtless limonite.

EPIDOTE.

Epidote occurs rather sparingly in the miarolitic cavities as minute greenish yellow crystals often aggregated into branching groups or strung, beadwise, on a thin fiber of hornblende. In some cavities larger greenish black crystals elongated on the $\bar{b}$ axis and showing terminal planes were found. These were made up of a large number of smaller crystals in parallel growth and did not yield good signals on the goniometer.

CHLORITE.

Chlorite was seen in some cavities associated with the larger epidote crystals as small deep emerald green spherules resting on albite crystals and made up of groups of folia. Under the microscope the mineral is found to be: Biaxial negative, with 2V small, 0° to 10°. The acute bisectrix is perpendicular to the perfect cleavage. Indices of refraction; $\alpha = 1.630$, $\beta = \gamma = 1.637$, $\gamma - \alpha = .007$. Pleochroism X = pale greenish-brown, Y = Z = deep blue green. Absorption X < Y = Z. This is similar to the chlorite described below as a vein mineral of which an analysis, made on a small sample, is given. It is tentatively referred to aphrosiderite.

HYDROTHERMAL ALTERATION.

As has been stated in an earlier part of this paper, the bulk of the diabase is entirely fresh and such alteration, aside from surface weathering, as has been observed is confined to the immediate vicinity of definite cracks, shear zones, and fractures in the normal rock or the diabase pegmatite. These seams which are accompanied by alteration are of several types and may be advantageosly described separately although they doubtless intergrade. The alteration, in most cases, is confined to a narrow and straight-walled zone paralleling

the crack on either side, which in the quarry shows as a narrow streak with a black or greenish narrow median line, bordered by a lighter colored zone. In the pegmatites, however, the alteration spread much further from the crack supplying the solutions, and gave larger masses of altered rock whose precise relation to fractures is rarely demonstrable. In this section are also described some fracture fillings which are not accompanied by alteration of the adjacent rock since the minerals of these fillings are the same as those which fill cracks elsewhere accompanied by alteration of the walls. The agency producing these phenomena is believed to have been solutions emanating as a final magmatic product, following the differentiation of the several textural and compositional facies of the diabase.

DIOPSIDE-FILLED CRACKS ACCOMPANIED BY DIOPSIDIZATION OF THE ADJACENT DIABASE.

Many of the streaks in the diabase have a green central line which consists of diopside filling the original open space of the crack, usually accompanied by intergrown contemporaneous chalcopyrite and pyrite. On either side of these diopside seams is a zone wherein the rock is greenish in color. This border extends to a variable distance from the central seam, usually of from 3 to 10 mm. making the total width of the streak from 6 to 20 mm. In extreme cases these streaks may be 30 mm. or more wide. One such streak of unusual width accompanied the narrow aplitic dike previously described and similar alteration often accompanies other such dikes. This is regarded as a coincidence rather than the result of the action of the aplite, since the alteration may have taken place previous to the aplitic injection along the crack later occupied by the aplite or subsequent to the intrusion of the aplite along the cracks formed by reopening of the same fissure. The greenish color of the altered rock is due to replacement of the normal purplish augite by diopside, hence this type of alteration is referred to as diopsidization of the rock.

In thin section the diopside along the center of the streak is like that of the adjacent wall rock, and there is usually a later very thin crack filled with chlorite. There are crystals of titanite along the crack. On either side of the fracture too and extending the entire width of the altered streak, diopside has replaced the original augite of the rock. Near the outer border of the altered area the replacement may be actually observed, as remnants of the original brownish augite remain in the centers of diopside crystals. Near the parent augite the diopside is crowded with opaque inclusions, but for the most part this pyroxene is clear and transparent and colorless to very pale green in section. Cross sections of the prismatic crystals show euhedral boundaries, well developed cleavage on (110) and twinning on (100). They have not, however, inherited the basal parting of the parent augite.

The feldspar of the altered zone is completely filled with a fine flaky sericitic micaceous alteration product of high birefringence. This extensive alteration masks the feldspar, making it indeterminable, although there is some evidence that it has been albitized in the altered zone, as well as sericitized. Titanite occurs in euhedral crystals along the crack and in irregular areas pseudomorphous after iron ore in the altered rock. Near the outer border of this zone replacement of titaniferous magnetite by titanite in all stages of completeness may be observed.

The principal reactions of the alteration have been the removal of iron and titanium from the augite and magnetite, with the substitution of some lime. The titanium has recombined in the titanite and has remained behind while the iron has apparently been removed from the vicinity. The total amount of alkalies has doubtless been increased by addition of soda to the feldspar in the form of the sericitic mineral, which is probably paragonite, and also perhaps as albite.

One diopside seam entirely like the one described and in normal rock was seen, having a central layer a millimeter or two thick of granular purplish axinite. Another diopside seam which cut an aplite dike contained a central seam of axinite in the diopside and widened occasionally with minute cavities which contained tufts of fibrous hornblende with crystals of axinite and epidote or were lined with axinite crystals and later filled with a white mineral, probably apophyllite. These occurrences are more fully described below under axinite.

CHLORITE SEAMS ACCOMPANIED BY HORNBLENDIZATION OF THE NORMAL ROCK.

Certain seams which resemble the diopside seams in having a deep green to black median line have been found to have a central filling of chlorite accompanied by hornblendization of the augite of the adjacent normal diabase. A typical example of such seams is shown in the illustrated specimen, plate 3, which may be described as follows:

The central chlorite-filled crack is ½ mm. in average width and on each side of this for a width of 1½ to 2 mm. the altered rock has a vivid deep green color. Beyond this there is a border a millimeter or so wide where the rock is whiter than normal.

In thin section under the microscope the central crack is seen to be filled with chlorite in aggregates of curved scales which yield shadowy extinction. This chlorite is intensely pleochroic in tones of deep blue-green parallel to the plates and pale brown in the direction perpendicular to the cleavage. The elongation of the traces of the plates is Z; so, assuming that the acute bisectrix is perpendicular to the basal cleavage, the mineral is negative. The chlorite merely fills open spaces and does not replace any of the primary minerals.

The hornblende which, in the altered zone, takes the place of the augite of the unaltered rock, is intensely pleochroic with X = pale brown, Y = deep greenish brown, Z = deep blue green. Absorption $Y > Z > X$. It is biaxial negative with 2V medium, Extinction $Z \wedge c = 16°$ maximum. Sections perpendicular to the prismatic elongation show well developed prismatic hornblende cleavage. Toward the border of the altered streak the hornblende grades into normal augite of the pinkish-brown type and cores of the augite are surrounded by the hornblende, lying in parallel position and extending inward by replacement.

One large grain of calcite was seen along the crack and this calcite contained included tufts of fine fibrous colorless hornblende, grown out from adjacent chlorite. Where chlorite abuts against a small open cavity the tufts of byssolitic hornblende occur grown in crystallographic continuity on the chlorite.

Titanite occurs as idiomorphic crystals included in the chlorite and also in the adjacent rock of the altered zone in all stages of replacement of the skeletons of original magnetite.

The original feldspar of the altered streak is completely filled with close packed sericitic alteration product, so that it is not possible to determine whether any replacement of the orginal plagioclase by albite has taken place. There are later borders of clear albite grown around cores of the original sericited feldspars, however, and where these abut against the chlorite filling, the outlines of the broken plagioclases have been completed by albite deposited from solution.

It will be noted that the alteration here described is identical with that along the diopside seams except in the nature of the ferromagnesian mineral which replaces the augite.

Where, as shown in the illustration, this seam crosses the coarse pegmatite streak, the crack continues sharply across. Whereas in the normal rock the alteration was confined to within some 3 mm. of the crack, in the coarse pegmatitic rock the agents producing the hornblendization of the augite, sericitization of the feldspar and replacement of iron ore by titanite were able to effectively penetrate farther and a completely altered large skeleton magnetite occurs fully 2 cm. from the crack.

One mineral was observed with the sericite as an alteration product of the feldspar adjacent to the crack which could not be identified. This was especially noted in an altered feldspar of a patch of micropegmatite. The mineral occurs as grains and small prisms which are colorless and have an index of refraction lower than that of the hornblende. It was roughly estimated to be about 1.60. It has strong birefringence and some sections give abnormal blue interference colors. It is biaxial positive with 2V small. The dis-

persion is very strong, $r < v$. Extinction highly inclined, about 45° in one direction and parallel in the other.

HORNBLENDE-FILLED CRACKS WITHOUT ALTERATION OF THE ADJACENT DIABASE.

In the central part of the quarry there are frequently seen broad plane surfaces veneered with glistening cleavages of a black mineral up to 2 by 3 mm. in size associated with a little biotite and chalcopyrite These are found to be old joint fractures which have been healed by later coarsely crystalline hornblende. Splitting tends to take place along the hornblende filling and leave broad surfaces exposed. Cross sections of these cracks show only a very narrow black line with no alteration of the wall rock.

A cross section cut from one of these showed the hornblende to be entirely a filling of the open space of the crack and the constituent minerals of the rock are entirely unaffected by any alteration. Where an augite blade has been broken in two by the crack, the intervening space is filled in by hornblende in parallel position. While most of the hornblende is of the dirty brown color, an occasional one is found tipped with blue hornblende in optical continuity.

The glistening black hornblende was examined in powder under the microscope and found to be biaxial negative with 2V medium. The indices of refraction are $\alpha = 1.660$, $\beta = 1.671$, $\gamma = 1.688$, Birefringence $\gamma - \alpha = .028$. The mineral is strongly pleochroic, with X = pale greenish brown, Y = deep greenish brown, Z = deep brownish green. The absorption is $Z > Y > X$. The optical orientation is $Y = b$ and the maximum extinction $Z \wedge c = 16°$.

BLUISH HORNBLENDE COATINGS ON FRACTURE SURFACES.

As has been noted under the discussion of jointing and fissuring, the breaks which characterize the east-west fractures are surfaced with a bluish gray coating, usually somewhat slickensided but easily distinguishable from the glossy black "diabantite varnish" of the north-south joints discussed under a later caption. This bluish material is mainly hornblende, although a small proportion of a light green chlorite also occurs. The best example of this hornblende coating seen is about 1 mm. thick and is pale blue-green with a silky luster and a peculiarly ribbed surface, recalling the ripple marks on shallow water deposited sediments.

Under the microscope the material of this coating is found to be finely fibrous with positive elongation, the extinction being about 13° maximum. It is pleochroic in brownish blue-green across the length and grayish blue-green parallel to the length. The indices of refraction are $\alpha = 1.630$, $\beta = 1.642$, $\gamma = 1.650$. It is obviously a hornblende.

The adjacent rock for an average distance of about 5 mm. is visibly altered, being somewhat bleached in appearance. In powder under the microscope the feldspars of this bleached zone are found to be filled with a fine muddy dust but show none of the coarse flaky sericite, nor are they albitized. The pyroxene is altered to colorless diopside which shows a grating structure, probably a pseudomorphous remnant of the cleavage cracks and basal parting of the original augite.

ALTERATION OF NORMAL DIABASE ADJACENT TO ZEOLITE-BEARING VEINS.

The rock of a number of zeolite specimens from shear zones which contained cavities filled with minerals, including prehnite, apophyllite, laumontite, etc., was examined to determine the extent and character of the hydrothermal alteration accompanying the filling of the zeolite veins. In the hand specimen, in contrast with the normal rock, this has a peculiar dead lack of luster and harsh dry feel, the feldspars are white and opaque-looking, and the dark minerals have a brownish to pistachio tinge. Sections were cut from the most intensely altered portions and under the microscope these were found to have suffered some alteration but no drastic mineralogical changes. The feldspars are extensively dusted with minute flakes of sericite, but have not been otherwise altered. The principal action on the augites has been the introduction of much finely flaky, yellowish green material, probably serpentine or a chlorite, into some crystals, while adjacent crystals are perfectly fresh. Iron ore is unchanged showing none of the replacement by titanite which marks the earlier hydrothermal alteration along seams.

A specimen from the strong shear zone at the south end of the quarry, where the dip of the joint system changes from west to east, had about the same microscopic characters.

These later vein-filling solutions apparently were lower in temperature and lacked the vigor of the earlier emanations which produced the preceding types of alteration.

"DIABANTITE VARNISH" ON SLICKENSIDED JOINTS.

The fact that the joints of the north-south systems are uniformly coated with a lustrous coating of slickensided black chlorite has already been noted. This forms layers up to 2 mm. in thickness having a smooth-polished, grooved-fibrous, lumpy, or rugose structure. These are entirely similar to coatings occuring in the Triassic traps throughout the Newark series. I have specially noted their occurrence in the quarries of the Westfield, Mass., where they are abundant.

When these layers are crushed and examined microscopically they are found to consist very largely of chlorite, although there is always some ground-up diabase incorporated with the chlorite, and for this reason the material was not suited for analysis.

Under the microscope the mineral is found to have a scaly structure and moderate pleochroism which, owing to the tangled character of the aggregates, is not conspicuous, X = brownish green, Y = Z = deep blue-green. The color and index vary somewhat, probably depending on slight differences in oxidation of the iron. The mineral is biaxial and negative (−) with 2V very small (±5°); acute bisectrix perpendicular to the basal cleavage, $\beta = 1.600$, varying .005.

The mineral is soluble in boiling 1:1 hydrochloric and nitric acids with separation of flocculent silica and is more slowly soluble in boiling dilute sulphuric acid. It is probably best referred to diabantite.

There is very little alteration of the adjacent rock along the diabantite-coated joints. Even the fragments of augite and feldspar incorporated in the chlorite are relatively fresh and free from alteration.

ALTERATION OF DIABASE PEGMATITE WHERE INTERSECTED BY DIOPSIDIC SEAMS.

While the processes which have developed the various coarse albite rocks seem in the quarry are somewhat obscure, they seem in part to be the result of both magmatic and hydrothermal processes. At one place where a number of diopsizing seams like those last described were traced from the normal diabase (where they produced the narrow altered zones described), into a coarse mass of diabase pegmatite, the seams became less well defined and alteration apparently due to them spread over a considerable part of the pegmatitic rock. This rock seemed to grade into normal diabase pegmatite away from the seams although the exposures were poor. In the hand specimen the material of this altered portion is light colored with the texture of the normal pegmatite and shows clear light green glassy prisms of diopside in a base of coarse granular snow-white to pinkish albite. Numerous skeletons of titanite pseudomorphous after magnetite are easily seen. The rock contains small cavities of the type here termed miarolitic, which are lined with albite crystals and partly filled with later tufts of snow white fibers of hornblende and occasional crystals of chalcopyrite. Such rock is common in the quarry. It may be a magmatic differentiate of the type called albitic pegmatite, and the fact that it is intersected by the diopside seams may not be significant.

In thin section under the microscope as shown in the photomicrograph, plate, 7 lower, this rock shows greatly sericitized and altered feldspar which is apparently all albite, and large grains and crystals of clear glassy diopside. No micropegmatite was seen. The pseudomorphs of titanite after skeletons of magnetite are abundant and well defined and the space between the plates of titanite is filled with spherulitic green chlorite. Where the small miarolitic cavities are sectioned the fine colorless hornblende needles are seen to be grown

on the ends of the diopside prisms in parallel position and many of the hornblende fibers are completely inclosed in the clear albite crystals which line the cavity and are later than the muddy albite of the rock on which they rest showing that the albite was contemporaneous with or later than the hornblende.

Rock such as this may have originated either by hydrothermal or magmatic processes and there has probably been a complex overlapping of such processes in the exposures of the Goose Creek quarry. While the material here described has many points in common with the albitic pegmatites regarded as magmatic products, the minerals formed secondarily are the same as those which were described as developing in the normal diabase along the cracks which intersect this particular mass.

HORNBLENDIZATION OF NORMAL DIABASE PEGMATITE ALONG CRACKS AND SEAMS.

Although a section was not made from the specimen illustrated in plate 3 where it is cut by the hornblendizing seam, sections were obtained from another larger mass of pegmatite where it was cut by a similar altered streak. These sections show some interesting features which may be described as follows.

The seam, which is traceable across the section, seems to contain two varieties of hornblende, one a brownish-green amphibole having a large extinction angle, up to 27°, which is pleochroic the color of mineral being in all directions of about the same proportions of brown and green but absorption is so complete in one direction that the mineral is almost opaque. The other is greener amphibole occurring in bundles of prismatic needles of positive elongation with the extinction $Z \wedge c = 17°$, which is pleochroic in X = pale greenish brown and Z = deep emerald green. These hornblendes also replace the augite of the rock. Usually the replacement in its first stages is by the brownest type hornblende which often surrounds an unreplaced core of augite. The completely replaced pyroxenes have a center of the brown hornblende, which is optically a unit, surrounded by the green one which has a confused uralitic structure. A little chlorite is locally associated with the hornblendes.

One peculiar feature of the rock near the seam is that some of the feldspars have altered by the development of a fine kaolinitic alteration product which has later been replaced by the green hornblende, a replacement which may be observed in all its stages. The end product of this process where the feldspar of micropegmatite has been replaced is a micrographic intergrowth of quartz and deep green hornblende (pl. 5, upper). Most of the plagioclases are fresh and clear except where they contain irregular and sporadic aggregates of coarse sericite flakes. Iron ore occurs as large skeletons of octahedral form largely replaced by titanite.

HORNBLENDIZATION OF DIOPSIDE OF ALBITE-DIOPSIDE PEGMATITIC ROCKS.

Many specimens of the coarse grained rocks consisting essentially of albite and diopside have suffered a change of the pyroxene, the glassy green diopside being replaced to various degrees by light fluffy aggregates of white fibers of hornblende, which is entirely like that described above as a mineral occurring in the miarolitic cavities. These altered rocks also show thin asbestiform coatings on cracks which have a pale bluish color, especially when wet. On dry specimens the blue material varies abruptly to white. Under the microscope this is seen to be composed of very finely matted fibers in which the pleochroism, which is not pronounced, is from pale greenish brown to pale brownish green. The extinction $Z \wedge c$ is variable up to 20°. The intermediate refractive index, β, is about 1.670. A few plates of "hour-glass" epidote are associated with this hornblende and a few grains of an unidentified mineral with an index well above 1.67 and intense pleochroism in deep grass green and purplish brown. These smears are entirely like the fibrous hornblende occurring in veins and miarolitic cavities as described in other sections of this paper.

HYDROTHERMAL JOINT AND CAVITY FILLINGS.

What have been referred to throughout the paper as zeolite-bearing veins are in reality small shear zones, usually only a few centimeters wide, composed of a breccia of fragments of crushed diabase or of its several differentiated phases, with the interspaces filled with secondary minerals deposited from solution. The earliest of these minerals are essentially the same as those occurring in the miarolitic cavities already described and are doubtless the product of deposition by the same solutions.

These shear zones with zeolitic minerals may follow either the north-south joints or the east-west fractures and there is no essential and constant difference between the minerals formed in shears of the two directions. In general specimens from the two series of ruptures can be distinguished by the darkening of the rock surfaces along the north-south system by diabantite varnish while the rock cemented by later minerals from the east-west fractures is lightened in color by a slight alteration which has already been mentioned.

Before discussing the origin and paragenesis of these veins the several minerals will be described in detail.

In this section are also described the minerals occuring as druses coating the surfaces of basalt blocks along early-formed flat cracks

ALBITE.

In addition to the abundant albite which occurs as a magmatic product in the later differentiates of the diabase and that which has

been described as occurring in crystals in the miarolitic cavities, some albite occurs in the shear zones as water-clear colorless crystals coating basalt, especially in specimens of one lot from along an east-west fissure. The specimens in which the albite occurred contained also chlorite, laumontite, amphibole, calcite, etc., and the albite appeared to be older than all of these. It is in druses of crystals which are uniformly small, rarely reaching 1 mm. in length. They are prismatic by elongation on the vertical axis and are untwinned. The prismatic faces are vertically striated. A typical crystal was measured, yielding the following angles:

Measurements of albite crystals from vein.

Form.		Symbol.		Quality description.	Measure.				Calculated.			
No.	Letter.	Gdt.	Miller.		ϕ		ρ		ϕ		ρ	
					°	′	°	′	°	′	°	′
1	*M*	0∞	010	Very poor	0	28	90	00	0	00	90	00
2	*T*	∞	110	Poor, striated	60	07	90	00	60	30	90	00
3	*l*	$\infty\overline{\infty}$	$1\bar{1}0$	do	119	07	90	00	119	52	90	00
4	*z*	$\infty\bar{3}$	$1\bar{3}0$	do	149	35	90	00	149	44	90	00
5	*P*	0	001	Poor, dull	80	43	26	25	81	51	27	01
6	*P*	$\bar{1}1$	$\bar{1}11$	Fair	$\overline{36}$	46	38	20	$\overline{36}$	53	38	30

The drawing, figure 5, shows the habit and appearance of these vein albite crystals. The albite is optically biaxial positive, 2V medium, $\beta = 1.530$, indicating pure soda feldspar.

CHLORITES.

The diabantite occurring as "varnish" on slickensides has already been noted and that coating the fragments of brecciated rock associated with zeolites from along north-south shears is in no wise different.

In several specimens from an east-west shear near the middle of the quarry face in October, 1922, the earliest deposit coating the rock fragments is a soft micaceous gray-green or blue-green layer underlying a film of the "mountain-leather" hornblende, above which is much stilbite and laumontite. Under the microscope this chlorite is seen to be made up of transparent flakes, occasionally with a suggestion of hexagonal outline, aggregated into rosettes. It is biaxial and negative $(-)$ but with 2V approaching zero. The acute bisectrix is perpendicular to the basal cleavage. Refractive indices, $\alpha = 1.625$, $\beta = \gamma = 1.630$, $\gamma - \alpha = .005$. Pleochroism X, pale yellow-green, Y and Z = bluish green, absorption X less than Y = Z.

These optical properties are practically identical with those given by Larsen for celadonite[22] but the material contains no potash and seems to be an ordinary chlorite. In places the material is oxidized somewhat, giving a yellow-brown color, increased birefringence, and higher refractive indices. Entangled with both this chlorite and the overlying hornblende are abundant flat "hourglass" crystals of epidote.

Another shear zone from about 100 feet south of where the last chlorite was found was exposed in August, 1923. This shear, which intersected broken and mashed but otherwise unaltered diabase pegmatite, contained prehnite and areas of a fine scaly soft gray-green chlorite, not immediately associated with the prehnite. This chlorite resembles the stilpnomelane from Westfield, Mass., which I have described,[23] but it is decomposed without oxidation by boiling with 1:1 nitric acid. Under the microscope it is seen to be made up of minute hexagonal scales. Basal scales are dark in all positions between crossed nicols and in convergent light yield a faint uniaxial or small biaxial negative figure with the acute bisectrix normal to the plates. The indices of refraction are $\alpha = 1.625$, $\beta = \gamma = 1.632$. It is pleochroic with X = clear brown, Y = Z = deep blue-green, absorption X < Y = Z.

A single small portion of this material was obtained in sufficient purity for analysis, yielding the following results:

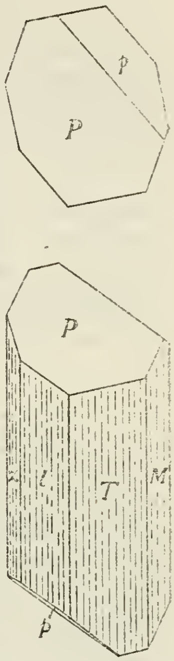


FIG. 5.—ALBITE; SHOWING PRISMATIC DEVELOPMENT OF COLORLESS TRANSPARENT ALBITE CRYSTALS OCCURRING IN FRACTURES AND VEINS.

Analysis of chlorite from shear vein.

Constituent.	Per cent.	Ratios.		
SiO_2	26.28	0.438	0.087×5	1.07×5
Al_2O_3	16.24	.159	.080×2	.98×2
FeO	31.62	.440	.088×5	1.07×5
CaO	.56	.011	.076×5	.93×5
MgO	14.74	.369		
H_2O+110° C	8.47	.470	.078×6	.95×5
H_2O−110° C	.30			
Total	98.21			

[22] Esper S. Larsen jr., Microscopic Determination of the Nonopaque minerals. U. S. Geol. Survey Bull. 679, p. 257, 1921.

[23] Earl V. Shannon. Diabantite, stilpnomelane, and chalcodite of the trap quarries of Westfield, Mass. Proc. U. S. Nat. Museum, vol. 57, pp. 397-403.

The chlorite thus approximates with moderate closeness to the formula,

$$5FeO.\ 5MgO.\ 2Al_2O_3.\ 5SiO_2.\ 6H_2O,$$

or, $$H_{12}Fe_5Mg_5Al_4Si_5O_{32}.$$

It is assumed that the iron is all ferrous although the material was too scanty to permit determination of its state of oxidation. This composition is intermediate and is not definitely referable to any of the named chlorites. It is doubtless related to diabantite and delessite but, for the present, no specific name will be applied to it. The material, as found, seems to be purely an introduction by solutions and not an alteration product of any constituent of the immediately adjacent rock. Paragenetically it is probably one of the earliest introductions into the vein, being essentially contemporaneous with the epidote and slightly earlier than the hornblende.

ASBESTIFORM HORNBLENDE.

In many specimens, especially of the lot collected from the shear zone in the north central part of the quarry in October, 1922, there is a snow white fibrous amphibole very similar to or identical with that described as occurring in the miarolitic cavities. This forms thin sheets of very fine fibers having a silky luster which occur coating joints in bleached and altered diabase along an east-west shear. These sheets are of paperlike consistency and can be peeled from the rock, giving a typical "mountain leather." The fibers are apparently oriented and the sheet, when placed flat, gives, from the aggregate of very fine fibers, a biaxial interference figure, with an acute negative bisectrix nearly perpendicular to the sheet and 2V large. The extinction in these fibers is strictly parallel. The mineral is insoluble in boiling concentrated hydrochloric acid although enough iron is extracted to color the solution yellow. A very small portion, only 14 milligrams, of this "mountain leather" was used for an analysis which obviously could yield only approximate results on so little material. This gave the following percentages:

Analysis of "mountain leather."

SiO_2	40.14
Al_2O_3	6.34
FeO	27.24
CaO	4.93
MgO	13.38
Total	92.03

The analysis serves to confirm the optical identification of the mineral as hornblende and to show that, despite its very white color, it is high in iron.

On the same specimens there are also silky tufts of white fibers of the same mineral which were better suited for a determination of the optical properties. These are associated with calcite, laumontite and albite crystals. They are definitely inclosed in calcite crystals and are clearly older than the laumontite but seem later than the water-clear prismatic albite crystals. One sheet of the papery variety was seen to overlie a layer of the chlorite last described and to underlie stilbite. This sheet of hornblende contained entangled epidote crystals.

The thicker fibers from these tufts show a suggestion of very pale blue green color under the microscope with pleochroism. They are biaxial negative with 2V large, dispersion $r < v$ weak. The extinction $Z \wedge \dot{c}$ is inclined 15° maximum, the mean of many measurements. The refractive indices are $\alpha = 1.648$, $\beta = 1.668$, $\gamma = 1.676$, all variable .005. Birefringence $\gamma - \alpha = .028$.

The mineral fuses in very thin splinters in the blowpipe flame to a black glassy bead which is strongly magnetic.

This fine fibrous hornblende is widely distributed and has been mentioned as being noted in thin sections. A specimen of hydrothermally altered aplite shows a later seam of diopside, along which are small open spaces containing this white hornblende in fine silky fibers on which are impaled crystals of epidote and axinite.

Although such asbestiform amphibole has not been frequently noticed in association with the zeolites of traps, Col. W. A. Roebling loaned the writer a specimen labeled paligorskite, regarding which he writes the following note: "This paligorskite came from the old Bergen Hill R. R. tunnel many years ago. I have forgotten who sent it to me—probably Rev. Dr. Spencer of Tarrytown."

This specimen contains small tufts of snowy fibers exactly like those of the Goose Creek specimens. These are interspersed with perfect stilbite crystals and larger calcites on a layer of drusy quartz. The base of the specimen is coarse slickensided diabase, the augite of which is chloritized. The slickensides are coated with diabantite varnish.

Under the microscope these fibers show a birefringence which reaches a maximum in first order yellow. They are biaxial negative with 2V large, axial plane parallel with the length. The extinction is inclined, $Z \wedge \dot{c}$ about 16° average. The indices of refraction are $\alpha = 1.652$, $\beta = 1.672$, $\gamma = 1.675$, $\gamma - \alpha = .023$.

The New Jersey amphibole is, therefore, almost identical in every detail of property and occurrence with the Goose Creek mineral.

EPIDOTE.

Scattered through the scaly chlorite, which forms the first coating on the altered rock of an east-west shear zone, as described above,

occur minute crystals of epidote of a peculiar type. These are also found entangled in the asbestiform amphibole of a number of specimens. These peculiar epidote crystals were observed in all of the specimens of this lot, but this is not an isolated occurrence of the mineral as shown by the fact that numerous crystals of the same type occur in specimens of prehnite collected in the quarry by Doctors Merrill and Wherry some eight years previously.

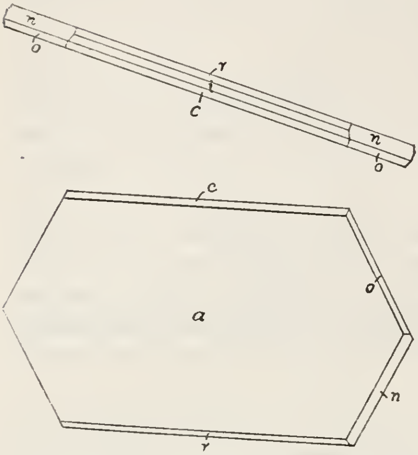


FIG. 6.—EPIDOTE. CRYSTALLOGRAPHIC DRAWING IN CLINOGRAPHIC AND ORTHOGRAPHIC PROJECTION OF EPIDOTE OF THE HOURGLASS TYPE.

The crystals are flattened on the front pinacoid *a* (100) in the orientation adopted and are moderately elongated on the *b* axis, the habit and development being uniformly as shown in orthographic and clinographic projections in figure 6. The angles measured on two different crystals with the elongation vertical are compared with the calculated angles for these forms in the following table. The agreement is as good as can be expected when the minute size and thinness of the crystals is taken into consideration. The dimensions of the two measured were 0.25 mm. long by 0.12 mm. wide by 0.01 mm. thick, this being the average maximum size.

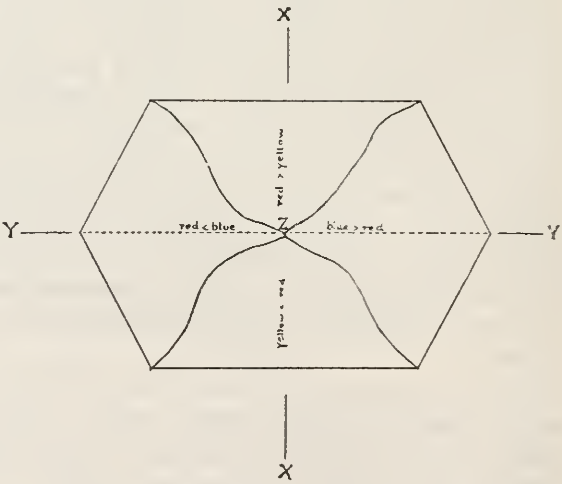


FIG. 7.—EPIDOTE. SKETCH SHOWING OPTICAL DIRECTIONS AND HOUR GLASS STRUCTURE. PROJECTION ON *a* (100).

The drawing, figure 8, is an orthographic projection on *b* (010) showing the optical orientation of the flattened crystals. Their principal peculiarity, optically, is an "hourglass" pattern which makes them beautiful objects under the microscope between crossed nicols. The appearance of the birefringence pattern is shown in the drawing

in figure 7, which is of a crystal between crossed nicols resting on the pinacoid *a* (100), the broad flat face. The colors of a typical example are indicated on the drawing.

This structure is not due to twinning but is due rather to difference in composition resulting in varying birefringence. The variation is probably in the amount of the iron-epidote molecule, this being greatest in the end sectors and gradually decreasing from center to outside in all sectors. The extinction is parallel to the sides of the crystals and the axial plane across the length, this tabular face being nearly perpendicular to the obtuse bisectrix. The crystals vary in color, in ordinary light, from colorless to pale greenish yellow with noticeable pleochroism, the color being distributed in the same pattern as the birefringence. This color is visible in the end sectors of the thicker crystals and in the inner tips of the side sectors.

The epidote is biaxial, negative (−), with 2V large. The indices vary with the zoning. One crystal gave, at the outer edges of the side sectors, which is the portion of minimum birefringence and probably of minimum index, $\alpha = 1.748$, $\beta = 1.754$.

This is typical "hour-glass structure," which is described by Iddings[24] as follows:

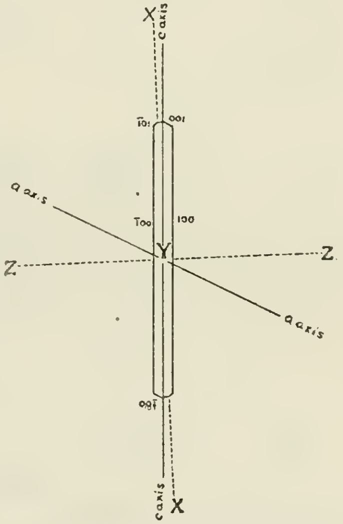


FIG. 8.—EPIDOTE. PROJECTION OF "HOUR GLASS" CRYSTALS ON *b* (010) SHOWING OPTICAL ORIENTATION.

> Differences in the molecular attractions in different directions in a crystal also show themselves in the constitution of some mixed crystals or crystals of isomorphous compounds. It appears as though certain molecules in the isomorphous series have a greater tendency to attach themselves in one direction than another; that is they are more strongly attracted to certain faces of the mixed crystal than to others. The crystal then differs in composition in segments built up of layers parallel to such faces, which may show themselves in differences of color or refraction. In some minerals the segments are pyramidal with the apexes of the pyramids toward the center of the crystal, and the bases at the surface. In sections of such crystals the reversed pyramids sometimes suggest the shape of an hour-glass, hence the term *hour-glass* structure. The commonest examples of such structure are found in augite in certain basaltic rocks.

While all of the epidote of this shear zone and that of the specimens collected by Merrill and Wherry are of this peculiar type, the epidote of the miarolitic cavities and that associated with the axinite were

[24] J. P. Iddings. Rock Minerals, p. 72, New York, 1906.

not of this type. A few hour-glass epidotes were seen, however, entangled with the amphibole of bluish smears on cracks in albitic pegmatite (see p. 53).

Paragenetically the epidote is contemporaneous with chlorite, asbestiform amphibole and also with the earliest prehnite, indicating that its formation covered a considerable period.

Angles of crystals of "hour-glass" epidote. Measured with elongation ($\bar{b}$ axis) vertical.

CRYSTAL 1.

Form.		Symbol.		Quality description.	Measured.				Calculated.			
No.	Letter.	Gdt.	Miller.		φ''		ρ''		φ''		ρ''	
					°	′	°	′	°	′	°	′
1	*t*	∞0	100	Triple signal	0	02	90	00	0	00	90	00
2	*c*	0	001	Very poor, dull	64	24	91	49	64	36	90	00
3	*r*	−10	$\bar{1}01$	do	$\bar{5}2$	03	90	00	$\bar{5}1$	42	90	00
4	*j*	$-\frac{1}{2}0$	$\bar{1}02$	Medium, double.	$\bar{8}1$	25	90	00	$\bar{8}1$	03	90	00
5	*n*	−1	$\bar{1}11$	Good.	$\bar{5}4$	43	36	09	$\bar{5}1$	54	35	13
6	*o*	01	011	Very poor shim.	64	47	33	18	64	36	31	31

CRYSTAL 2.

Form.		Symbol.		Quality description.	Measured				Calculated.			
No.	Letter.	Gdt.	Miller.		φ''		ρ''		φ''		ρ''	
					°	′	°	′	°	′	°	′
1	*t*	∞0	100	Multiple signal.	0	01	90	15	0	00	90	00
2	*c*	0	001	Very poor, dim	64	30	90	00	64	36	90	00
3	*r*	−10	$\bar{1}01$	Very poor, narrow.	$\bar{5}1$	47	90	00	$\bar{5}1$	42	90	00
4	*i*	$-\frac{1}{2}0$	$\bar{1}02$	Medium, poor	$\bar{8}0$	34	91	33	$\bar{8}1$	03	90	00
5	*n*	−1	$\bar{1}11$	Medium	$\bar{5}3$	02	34	52	$\bar{5}1$	42	35	13
6	*o*	01	011	Very poor, shim.	66	43	33	15	64	36	31	31

AXINITE.

Axinite was found in two places in the quarry. North of the central part of the quarry face a diopside seam in a loose block of normal diabase had a layer from 1 mm. to 2 mm. of granular axinite in the center. This is purplish in color in the hand specimen and under the microscope is colorless, transparent, biaxial negative (−), with 2V medium large, $r < v$ strong

South of the central part of the quarry face an aplite dike from 2 cm. to 3 cm. wide is cut by later seams filled with diopside and where these diopside seams widen they have a central layer of purplish-gray axinite. In places the axinite seams contain minute vugs lined with acute wedge-shaped axinite crystals of purplish-brown color. The central portion of these vugs is filled with cottony white hornblende which contains embedded perfect crystals of axinite and a few long prismatic crystals of epidote. One such axinite-lined cavity was filled with a white mineral which, when examined microscopically, was found to contain numerous included colorless hornblende fibers. This white mineral which is biaxial, positive with 2V small, r>v pronounced, has a perfect cleavage perpendicular to the acute bisectrix and is doubtless apophyllite. Its refractive index, β is 1.538.

The axinite crystal which was measured was one of the perfect individuals suspended on hornblende fibers. It has the form and habit shown in figure 9 and gave the following measurements:

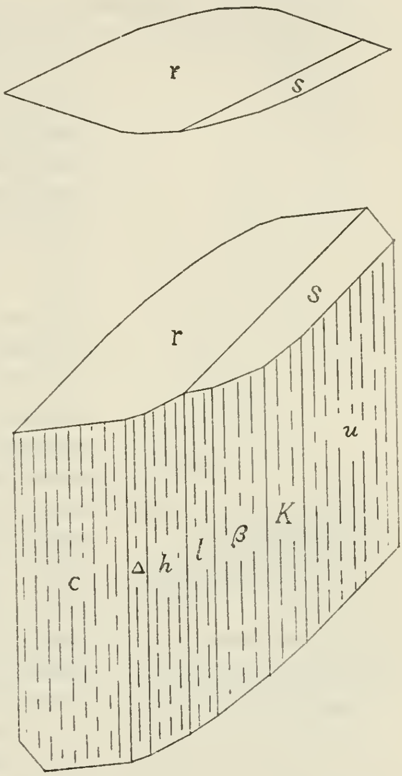


FIG. 9.—AXINITE. SHOWING COMMON HABIT OF CRYSTALS FROM GOOSE CREEK. ORTHOGRAPHIC AND CLINOGRAPHIC PROJECTION ON *c* (010).

Measurements of axinite from Goose Creek.

Form.		Symbol.		Quality description.	Measured.		Calculated.	
No.	Letter.	Gdt.	Miller.		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	$\underline{c}$	0∞	010	Fair	0 27	90 00	0 00	90 00
2	$\underline{u}$	$\infty\infty$	$1\bar{1}0$	Good	135 27	90 00	135 24	90 00
3	$\underline{l}$	$\infty\bar{2}$	$1\bar{2}0$	Very poor	152 36	90 00	151 23	90 00
4	$\underline{h}$	$\infty\bar{3}$	$1\bar{3}0$	Poor	156 04	90 00	158 38	90 00
5	β	$\infty\frac{\bar{5}}{3}$	$3\bar{5}0$	Very Good	147 55	90 00	147 03	90 00
6	$\underline{K}$	$\infty\frac{\overline{11}}{9}$	$9.\overline{11}.0$	Poor	140 41	90 00	139 58	90 00
7	New?	n.c.	n.c.	Medium	169 33	90 00	n.c.	90 00
8	$\underline{s}$	$1\bar{2}$	$1\bar{2}1$	Fair	153 39	68 17	153 49	68 32
9	$\underline{e}$	01	011	Very good	7 58	45 12	7 58	45 16

The faces of the crystals are all lustrous and brilliant but the prismatic planes are striated vertically and somewhat rounded by oscillation.

The optical properties of this axinite are: biaxial, negative (−), 2V medium large, r<v moderate, $\alpha=1.673$, $\beta=1.680$, $\gamma=1.684$, $\gamma-\alpha=.011$. In the granular portion of the taxinite seam chalcopyrite, apparently contemporaneous, is intergrown with theaxinite. Paragenetically the axinite is placed as contemporaneous with chalcopyrite, epidote, and hornblende, and earlier than apophyllite.

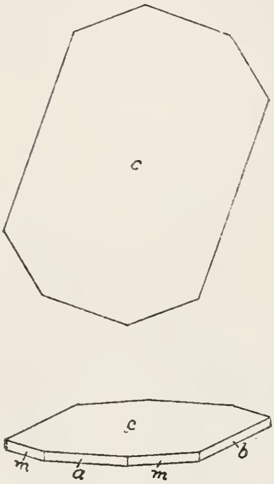


Fig. 10.—Prehnite. Type 1 crystal. Orthographic crystal drawings.

QUARTZ.

The scarcity of quartz is rather a notable feature of the Goose Creek assemblage of vein minerals. This mineral, so common elsewhere in association with zeolites in trappean rocks, was seen only once in all the specimens collected. In this instance it occurred as combs of prismatic crystal grown out from either wall of a vein. The crystals rested upon a layer of chlorite. The individual quartz crystals average 2 millimeters long by 1 millimeter thick and are transparent, colorless, and brilliant. They have the common habit, hexagonal prism terminated by a symmetrical hexagonal pyramid. The vein between the quartz combs is filled with coarse granular datolite which preserves molds of the quartz crystals when they are broken out. The whole vein averages about 1 centimeter wide. A single small cube of galena was seen in the chlorite underlying the quartz. Paragenetically the quartz is later than chlorite and galena and older than datolite.

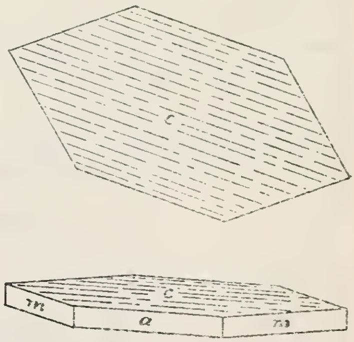


Fig. 11.—Prehnite. Type 2 crystal elongated on the *b* axis showing crystal habit and striation of *c* (001).

PREHNITE.

Prehnite is the most abundant of the vein minerals and occurs in a variety of forms.

In the lot of material collected from this locality in 1915 by Doctors Merrill and Wherry, the prehnite exhibits the ordinary form, pale green columnar crusts with botryoidal to ill-defined cockscomb surface. This prehnite rests upon a layer of somewhat weathered

chlorite and contains embedded "hour-glass" epidote crystals. Apophyllite crystals rest upon the surface of the prehnite.

In the material collected from the east-west shear zone in the north-central portion of the quarry face in October, 1922, prehnite is abundant, especially as sheeted vein fillings made of pale green material having a transverse-bladed structure and showing evidence of repeated reopening of the fissure during its deposition by the inclusion of many layers of chlorite and partings parallel to the walls, giving a sheeted structure. Small open spaces in this material are lined with minute tabular and very thin crystals. The thinner of these have the form shown in figure 10 and give very poor but definite reflections from the prism faces indicating a prism angle of about $80° \pm 2°$. The faces of pinacoids, though visible, are etched dull and give no reflection. When these small euhedral crystals are examined in polarized light they give very remarkable effects. Crystals like those indicated in the drawing, figure 10, are shown in figures 13 and 14 below, and in figure 15 is shown a variant which is bounded by only the two pinacoids, *a* (100) and *b* (010) giving rectangular plates. These peculiar crystals are referred to as "hour-glas" prehnites by analogy with the associated epidotes described above. The cause of the appearance is very different in the two cases as will be apparent from the following description.

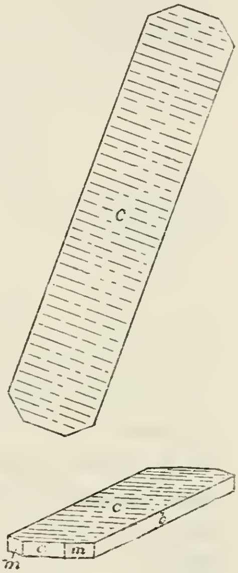


Fig. 12.—Prehnite. Type 3 elongated on the *a* axis showing striation and crystal habit in orthographic and clinographic projection.

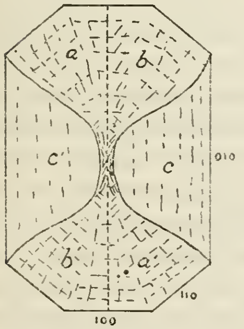


Fig. 13.—Prehnite. Type I showing common "hour-glass" form.

The crystal, figure 13, consists of an hour-glass pattern at the ends and continuing as a narrow line through the center of the crystal to connect with an identical area at the corresponding opposite end. The main portion of this crystal, marked $c - c^1$ in the drawing, shows, at the position of maximum illumination, a uniform pale-yellow birefringence color of the first order. The extinction is parallel with the sides. The figure, in convergent light, shows an optically biaxial positive character, with 2V medium, acute bisectrix perpendicular to the plate, $r > v$ distinct. Axial plane parallel with the long direction which makes the optical orientation $X = a$, $Y = b$, $Z = c$.

When this main portion of the crystal is at the position of extinction the end portions, $a-a^1$ and $b-b^1$, have a uniform and identical first-order yellow birefringence color, which is probably their maximum birefringence. Their optical directions are thus inclined 45° to those of the main portion of the crystal. They are moreover inclined 90° to each other, as is shown by the insertion of a first-order red gypsum plate when the sectors $a-a^1$ become blue and $b-b^1$ become yellow or vice versa.

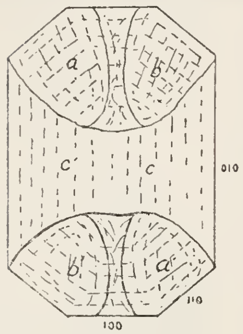


Fig. 14.—Prehnite. Type I showing a modification of the "hour-glass" structure where the two end sectors are not connected.

These end sectors $a-a^1$ and $b-b^1$ yield no true extinction between crossed nicols, but only sweeping bars as the stage is rotated, and their birefringence colors are abnormal low-order blue and liver brown. Any area in these sectors, in convergent light, gives a confused interference figure which is biaxial, positive, with 2V very small to small, $r<v$ extreme, crossed dispersion extreme, acute bisectrix normal to the plate.

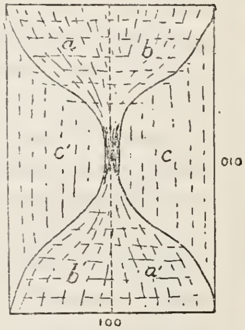


Fig. 15.—Prehnite. Type 1 showing hour-glass structure in a crystal bounded only by pinacoids.

The example illustrated in figure 14 is the same case except in the shape of the "hour-glass" pattern.

In the case of these crystals, which are the simplest examined, the anomalous optical behavior can most easily and satisfactorily be explained by assuming an underlying normal prehnite crystal, of uniform thickness and normal optical properties, overlain by a scale having the outline of the hourglass and made up of two crystal individuals oriented at right angles to each other and at 45° to the underlying crystal. All of the anomalous birefringence, dispersion, and confused optical figures can be simply accounted for by this interpretation.

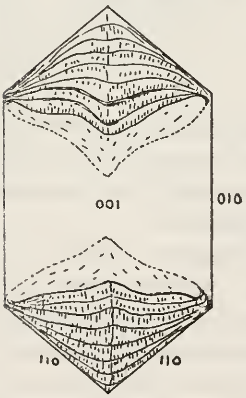


Fig. 16.—Prehnite. A variant of type I showing the growth of thickening at the ends to produce sheaves.

The crystal illustrated in figure 15 is similar. Here the plate is rectangular and is bounded only by the pinacoids a (100) and b (010). When the main crystal $c-c'$ is at the position of extinction, which is parallel to its edges, the hour-glass portions show only a very faint luminosity, which gives the same effect as the preceding with the sensitive tint, but

barely perceptibly. The main portion of the crystal shows interference colors mostly in subnormal blue and liver brown with a very little first-order yellow. All portions of the pattern yield a similar interference figure in convergent light, biaxial positive, 2V approximately 10°, acute bisectrix perpendicular to the table, axial plane parallel with the long direction, r > v strong. These interference figures are somewhat hazy and confused. This is most probably like the preceding, but the portions of scales making up the "hourglass" are so exceedingly thin that they do not greatly obscure the optical properties of the main crystal, even though the latter is itself very thin.

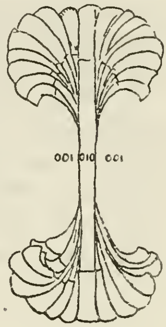


FIG. 17.—PREHNITE. A SIDE VIEW OF CRYSTAL AGGREGATE SIMILAR TO THAT SHOWN IN FIGURE 16.

The explanation implying an overgrowth of scales is not purely hypothetical, especially since any of the crystals when carefully examined under a lens do show such scales, indeed usually a group of them, curving upward. This is similar to the tendency of the crystals of prehnite to form sheaves and the flat crystals, with a thin overlying scale, grade into bundles of curved, scalelike crystals. Two such aggregates are illustrated in figures 16 and 17; the form shown in figure 17 is very much more common than any other and has been referred to as "dumb-bell" prehnite. Drusy surfaces are often made up of this type grading into still more globular forms and the crystals of the preceding descriptions rest, in most cases, upon such shapes.

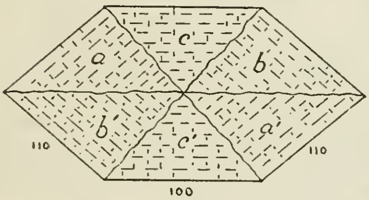


FIG. 18.—PREHNITE SHOWING OPTICAL STRUCTURE OF CRYSTALS OF TYPE 2.

In an east-west shear zone exposed just south of the center of the quarry in August, 1923, there were found some specimens of prehnite made up of pale yellowish-green columnar bladed crusts up to 1 cm. thick lining an open space. The surfaces of these crusts are smooth botryoidal but are made up of the terminations of innumerable closepacked crystals. Attached to this crust as though later are single, well-defined crystals of prehnite up to 3 mm. broad, which are more abundant and more perfect where the space between the crusts is narrow. These have the crystal habit shown in figure 11, showing the prism m (110), the front pinacoid

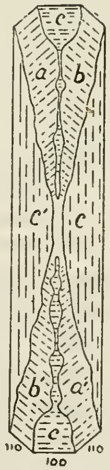
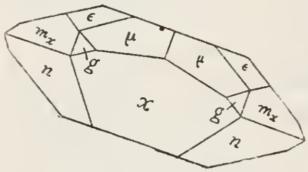


FIG. 19.—PREHNITE SHOWING OPTICAL STRUCTURE OF CRYSTALS OF TYPE 3.

a (100), and the base *c* (001). They are thick tabular, parallel to the base, and are elongated on the $\bar{b}$ axis, as contrasted with the foregoing, which are elongated on the $\acute{a}$ axis. The pinacoid *a* (100) is etched dull but the prismatic faces give good reflections, indicating the angle m (110) $\wedge$ m''' $(1\bar{1}0) = 80° 39'$. The basal pinacoid is striated parallel to the $\bar{b}$ axis as indicated in the drawing.

Between crossed nicols these crystals also show optical anomalies, the pattern being as shown in figure 18. These are in many respects like the ones previously described but they are somewhat more complicated. When the sectors *c* and *c′* are at the position of extinction *a*, *a′* and *b* and *b′* are similarly illuminated and show a uniform first-order yellow interference color. These sectors give symmetrical extinction of 8° on either side of the dividing line. The extinction is not uniform, however, but sweeps as a bar from the inner tip of the sector outward. At 45° position all sectors are similarly illuminated. *a* and *a′*, *b* and *b′* shade from a broad central yellow field downward through black to blue at the edge. *c* and *c′* shade similarly from a yellow central field through black and then have a narrow outer border of higher colors. No segment is simple. Even the *c* and *c′* sectors which have homogeneous parallel extinction give, in convergent fight, an interference figure like that obtained from twomuscovite plates superposed at right angles to each other, while the end sectors give still more complicated interference figursə, suggesting 3 mica plates at 60° to each other. The acute bisectrix of allof the intergrown crystal units is perpendicular to the table.



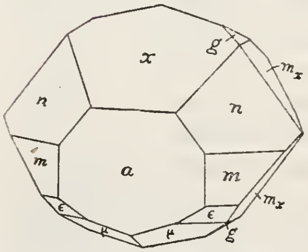
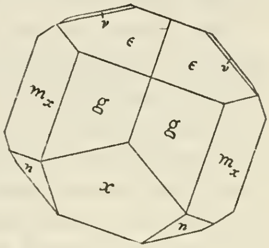


Fig. 20.—Datolite of first generation showing acute habit.

The simplest explanation which will fit these several peculiarities is that the crystals are made up, as before, of an underlying homogeneous crystal which, however, is not of uniform thickness but thickens in all directions from the center. Thinning would produce the same result but the thickening is actually noticeable when the prehnite crystals are examined. This simple tapering crystal is overlain by layers having the arrangement of the sector pattern, figure 18. In *c* and *c′* there is one overlying plate with optical directions at right angles to those of the fundamental crystal beneath. In $a-a'$ and $b-b'$ three layers, the two upper being oriented at 90° to each other and 45° to the underlying crystal.

A small vein in the south end of the quarry varied from 1 to 2 cm. wide and was filled with granular fine green porous prehnite. The cavities are lined with brilliant little crystals which are elongated on the *á* axis and have the crystal habit shown in the orthographic and clinographic drawings of figure 12. The prism faces gave good measurements indicating the prismatic angle to be 80° 59′. The front pinacoid also gave good signals but the side pinacoid (010) is etched dull. The base is horizontally striated as indicated. Between crossed nicols these crystals gave the pattern shown in figure 19. Although at first glance appearing more complicated, this is found to be only a variation of the structure shown in figure 18, and is capable of the same interpretation.



These interpretations are applicable only to the prehnites here described and this mineral seems to adopt numerous other confused intergrowths producing other effects as shown by the discussions of Mallard and Emerson abstracted in Dana's Mineralogy.

The green prehnite from one of the sheeted veins was purified for analysis and analyzed in the Museum laboratory yielding the results given in column 1 below. In column 2 are quoted the results obtained on analysis of prehnite from Admiralty Inlet, and in column 3 the theoretical composition.

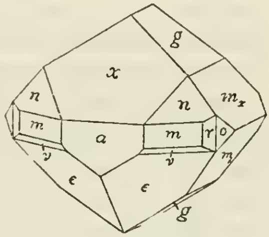


FIG. 21.—DATOLITE OF SECOND GENERATION SHOWING MORE PRISMATIC HABIT BY ELONGATION ON THE *a* AXIS

Analyses of prehnite.

	1. Goose Creek.	2. Admiralty Inlet.	3. Theory.
SiO_2	41. 90	44. 35	43. 7
Al_2O_3	19. 38	19. 44	24. 8
Fe_2O_3	6. 93	6. 58	----------
FeO	. 48	----------	----------
CaO	26. 70	25. 50	27. 1
MgO	. 41	----------	----------
BaO	Trace.	----------	----------
H_2O+110° C	4. 84	4. 00	4. 4
H_2O−110° C	. 06	----------	----------
Total	100. 70	99. 87	100. 0

The comparison of the above analyses indicates that the prehnite from this locality is ordinary in composition except in being rather higher than usual in ferric-iron, a little higher, in fact, than the prehnite from Admiralty Inlet described by Johnston[25] to which the varietal name "ferriprehnite" has been applied. That the iron is present as ferric oxide replacing alumina rather than as ferrous oxide replacing lime was definitely determined.

The optical properties of the analyzed powder were found very difficult of determination. The confused optical structures observed in the relatively simple crystals described above are greatly multiplied in the massive material. Although composed of pure prehnite the sample gave variable refractive indices and is clearly somewhat zoned with some variable constituent, probably ferric oxide, affecting the indices of the different zones. The average indices, which are the best that could be obtained, are $\alpha = 1.635$, $\beta = 1.640$, $\gamma = 1.655$. The mineral is biaxial positive and the value for 2V varies from nearly 0° to about 30° or more with an average of 15°. The dispersion, $r < v$, varies from weak to extreme, most intense in the grains of smallest axial angle. Confused interference figures give extreme crossed dispersion.

Paragenetically the prehnite is early, definitely earlier than stilbite, laumontite, apophyllite, and calcite. In most specimens it precedes datolite but in other specimens crusts of datolite crystals are overlain by clearly later crusts of "dumb-bell" prehnite. Evidence definitely proving whether this means two generations of prehnite or two of datolite was not found. From the existence of two types of crystallization of the datolite, however, it is assumed that there are two generations of the datolite and only one of prehnite.

DATOLITE.

Datolite occurs in a large number of specimens and has been assumed to be of two generations because in many specimens it is underlain by a thick crust of prehnite while in others the datolite crystals are more or less covered by a later crust of prehnite, although both generations of datolite were nowhere found in the same specimen.

The first datolite found in the quarry, in October, 1922, was only yellowish transparent granular material on diabase, not associated with any other mineral, although laumontite occurred on the opposite sides of the same specimens. This was identified by its characteristic optical properties which are: Biaxial, negative (−), 2V large, $r > v$ weak, $\beta = 1.653 \pm .002$.

[25] R. A. A. Johnston, Canada Geol. Surv. Victoria Memorial Museum, Bulletin 1, p. 95, 1913

The second lot of datolite specimens was obtained from a north-south fissure in April, 1923, and contained numerous crystals of datolite as the earliest mineral of the veins, covered by later prehnite, laumontite, stilbite, and calcite. These are greenish transparent crystals of acute pyramidal habit as illustrated in figure 20. They average 3 mm. in length and greatly resemble the crystals of datolite from Bergen Hill. Entirely similar crystals line narrow veins later solidly filled with white apophyllite.

The crystals are fairly simple in combination with the forms *a* (100), *m* (110), *n* (111), and *x* (102) prominent with smaller faces of μ ($\bar{1}14$), ϵ ($\bar{1}12$), m_x (011), and *g* (012). The crystals of this type which were measured gave the following angles:

Measurements of datolite crystals, Figure 20.

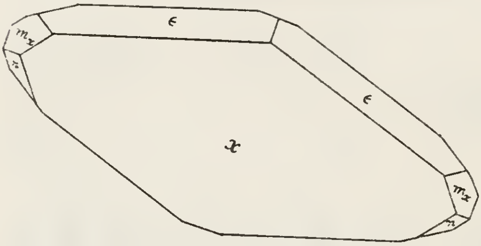
Form.		Symbol.		Quality description.	Measured.				Calculated.			
No.	Letter.	Gdt.	Miller.		φ		ρ		φ		ρ	
					°	′	°	′	°	′	°	′
1	*a*	$\infty 0$	100	Excellent ----	90	00	90	00	90	00	90	00
2	*b*	0∞	010	Very poor----	0	00	90	00	0	00	90	00
3	*m*	∞	110	Excellent ----	57	30	90	00	57	37	90	00
4	m_x	01	011	-----do ------	0	04	51	30	0	07	51	41
5	*g*	$0\frac{1}{2}$	012	Very poor----	0	04	30	30	0	14	32	19
6	*x*	$+\frac{1}{2}0$	102	Excellent ----	89	19	44	41	90	00	45	00
7	*n*	$+1$	111	-----do ------	57	26	67	04	57	38	67	04
8	ϵ	$-\frac{1}{2}$	$\bar{1}12$	Very good----	$\bar{5}7$	20	49	42	$\bar{5}7$	33	49	42
9	μ	$-\frac{1}{4}$	$\bar{1}14$	Medium -----	$\bar{5}7$	25	30	25	$\bar{5}7$	29	30	29

When overlain by prehnite or other minerals these crystals often have some of the faces etched to complete dullness, although those which are completely covered by apophyllite are brilliant with all of the faces lustrous.

The second type of datolite, which invariably rests upon a columnar or bladed green crust of earlier prehnite, was first seen in a little specimen picked up on the quarry floor by W. S. Burbank in April, 1923. These crystals have the same yellow-green color and are transparent. They differ in habit, however, and are more prismatic by elongation on the *a* axis, making the clinodomes prominent. In this respect they somewhat resemble the crystals from Westfield, Mass. One such crystal was measured and had the development shown in the drawing, figure 21. This gave the following angles:

Measurements of datolite, Figure 21.

Form.		Symbol.		Quality description.	Measured.				Calculated.			
No.	Letter.	Gdt.	Miller.		φ		ρ		φ		ρ	
					°	′	°	′	°	′	°	′
1	m	∞	110	Very good	57	35	90	00	57	37	90	00
2	o	$\infty 2$	120	Very poor	37	47	90	00	38	14	90	00
3	r	$\infty\frac{2}{3}$	230?	do	43	02	90	00	46	25	90	00
4	x	$\frac{1}{2}0$	102	Excellent	90	00	45	02	90	00	45	00
5	m_x	01	011	do	0	10	51	47	0	07	51	41
6	g	$0\frac{1}{2}$	012	do	0	24	32	27	0	14	32	19
7	n	1	111	do	57	37	67	16	57	38	67	04
8	ϵ	$-\frac{1}{2}$	$\bar{1}12$	Very good	$\bar{5}7$	31	49	25	$\bar{5}7$	33	49	42



The forms r (230) and o (120) are present as small and dull etched faces. No measurement was obtained on ν ($\bar{1}11$), which was identified by its position; ϵ ($\bar{1}12$) is etched so as to give a reddish signal. All of the other faces are plane and brilliant, giving excellent reflections.

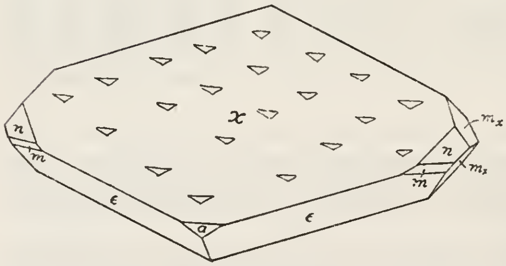
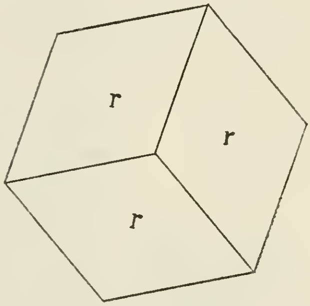


Fig. 22.—Datolite of second generation showing pronounced tabular development parallel to x (102).

In the late summer, 1923 numerous specimens of this postprehnite datolite were found, mostly granular but some showing free crystals.

A specimen handed to me by the owner of the quarry in August, 1923, had been laid aside by the quarry foreman, and what part of the quarry it came from was not known. This had a relatively large cavity filled with datolite surrounded by an earlier crust of prehnite. The datolite crystals of this specimen are the most flattened crystals of this mineral which have come under my notice. The largest of these may reach a breadth of 15 mm. with a thickness of only 1 mm. They are imperfectly developed and it was found impossible to orient them except by placing them on the flat side and examining them optically. The emergence of an optic axis nearly perpendicular to the flat face identified it as the dome x (102), and this, together with the position of the optic axial plane, served to orient them. It was

found most advantageous to measure these in the Goldschmidt position. The faces, except x (102), are small, and those of a (100), m (110), and ϵ ($\bar{1}12$) are etched to complete dullness. The tabular face x (102) and n (111) give fair reflections and m_x (011) gives excellent signals. The broad face of x (102) is marked by triangular elevated spots with apices pointing toward a (100) and bases upward toward the position of c (001). The habit of the crystals is indicated in the drawing, figure 22, although in this position the tabular habit of the crystals is not so obvious.



CHABAZITE.

Chabazite is one mineral which was found only as drusy coatings along very narrow cracks in unaltered basalt and not in the wider shear zone veins associated with the other minerals. The drusy coatings are common and often cover considerable areas, sometimes of a square meter or more. The chabazite is deposited directly on the basalt and is often overlain by later stilbite and calcite.

This zeolite is usually in the form of simple rhombohedral crystals of the common unit rhombohedron r as shown in figure 23, or, rarely, interpenetrating twinned rhombohedra. The crystals, which are transparent-colorless to translucent white average only about 1 mm. in diameter. They sometimes are grown into groups in parallel position.

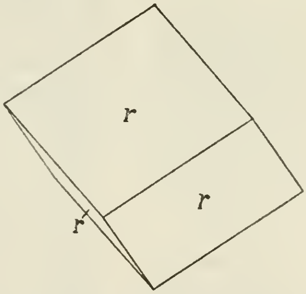


FIG. 23.—CHABAZITE SHOWING UNIT RHOMBOHEDRON, THE COMMON FORM AT GOOSE CREEK.

The comparatively poor crystals which were measured indicated an average rho angle of 52° 48′ for the rhombohedron (calculated = 51° 25′). There is a moderately perfect cleavage parallel to this rhombohedron.

Optically examined in powder under the polarizing microscope the mineral is found to be zoned parallel to the rhombohedral faces. The central portion of the crystal has the lowest refractive indices, lowest birefringence, and smallest axial angle, the index of refraction, birefringence, and axial angle increasing toward the outside. The mineral thus varies from uniaxial at the center to biaxial with 2V moderate at the peripheries. The indices of refraction vary similarly from $\alpha = 1.485, \beta = 1.485, \gamma = 1.490$ to $\alpha = 1.488, \beta = 1.490, \gamma = 1.495$. The optical character is positive.

STILBITE.

Stilbite is a common mineral in the veins, being exceeded in amount only by prehnite, apophyllite, laumontite, and datolite. It occurs characteristically as minute colorless transparent crystals and larger groups of parallel crystals or nearly parallel individuals forming larger units. These stilbite crystals are associated with all of the other vein minerals and often rest upon prehnite. The smallest of these are all rectangular prisms bounded only by three pinacoids at right angles to each other as shown in figure 24. These become less perfect with increase in size until the larger ones, which are 1 cm. long by 4 mm. wide and 2 mm. thick, show a group structure, the smaller individuals making up the group showing a slight tendency to diverge and form sheaves, although made up of rectangular units. These have a not very pronounced pearly luster on the broader face. One specimen showed minute colorless transparent rectangular crystals bristling in all directions from the base to which they are attached and forming a loose hemisphere. These rest upon a "mountain leather" layer of hornblende and are overlain by laumontite. One of the most perfect of these was measured and gave angles of 90 degrees between the pinacoids, within the limit of error of the measurements. These crystals are biaxial, negative, 2V small, $r>v$ weak, $\beta=1.498$. Lying on the broad face between crossed nicols these show the emergence of the optic normal with a very small inclination, of but a degree or two, of the extinction to the edge, and show a faint suggestion of twinning. When crushed they exhibit two cleavages, one perpendicular to the optic normal or parallel to the plane of the optic axes (010), and a second, nearly as perfect, parallel to the front pinacoid (100) which is perpendicular to the obtuse bisectrix. This makes the optical orientation, if the crystals are set with their elongation vertical, $Y=b$, $Z=a$, $X \wedge c=0°-2°$.

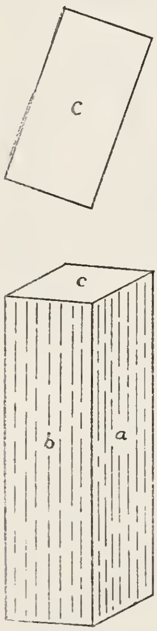
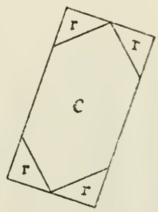


FIG. 24.—STIBITE OF "EPIDESMINE" HABIT BOUNDED ONLY BY THREE PINACOIDS.

Another specimen showing the larger crystals or rather bundles of crystals in parallel position, furnished material for a partial analysis which furnished the results of column 1 of the following table. In column 2 are given the figures of the theoretical composition of stilbite, taken from Dana, and in column 3 the analysis by Thugutt and Rosicky of epidesmine.[26]

[26] Appendix III, Dana Syst. Min., p. 27.

Constituent.	Goose Creek.	Theory.	Epidesmine.
SiO_2	54. 40	57. 40	56. 66
Al_2O_3	17. 88	16. 30	16. 00
CaO	8. 56	7. 70	7. 58
MgO	----------	----------	. 06
K_2O	----------	----------	. 67
Na_2O	----------	1. 40	. 88
$H_2O+110°C$	16. 00	17. 20	18. 69
$H_2O-110°C$	2. 32		
Insoluble	----------	----------	. 44
Total	99. 16	100. 00	100. 98



Enough of the Goose Creek material was not available for determination of the alkalies which, judging from the summation of the analysis, must be small in amount. The analyzed material had the following optical properties: Biaxial, negative, 2V medium, $\alpha=1.490$, $\beta=1.500$, $\gamma=1.502$, $\gamma-\alpha=.012$. There are two perfect cleavages parallel to the two elongated pinacoids. The best of these adopted as *b* (010), gives maximum birefringence and is parallel to the optic plane, giving extinction varying from 0° to 5°. The other cleavage is perpendicular to the obtuse bisectrix which makes the orientation, like that of the smaller crystals from another s ecimen described above, $X \wedge c=0°-5°, Y=b, Z=a$.

Stilbite has been considered monoclinic and is so gi en by Dana, although crystals with the symmetry of that system have apparently never been found. T e assignment of the mineral to the monoclinic system of crystallization depends upon the optical structure of crystals which, when lying on the *b* (010) face, show optical anomalies with two twinning planes intersecting each other at right angles and dividing the crystal into 4 identical quarters.

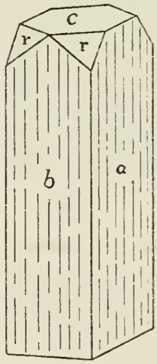


FIG. 25.—STILBITE OF THE USUAL HABIT SHOWING PYRAMIDAL FACES.

Goldschmidt has disregarded the optical structure and classes stilbite (=desmin, Germ.) as orthorhombic.

Epidesmine has been described as an orthorhombic mineral having crystals bounded by three pinacoids at right angles to each other. While the formula given for epidesmine is slightly different than that here adopted for stilbite, the analysis, quoted above, is well within the limits of variation of stilbite analyses. The only distinction between stilbite and epidesmine would then appear to be that the crystals of the latter are presumably homogeneous with parallel extinction on (010) while the crystals of stilbite are twinned with a

small inclined extinction, up to 5°, on either side of the twinning plane.

The crystals of stilbite described above have the habit of epidesmine while the analysis gives the composition of stilbite. The crystals are zoned somewhat, the zones differing in refractive index but seeming to cover the very small range between the refractive indices of stilbite and those of epidesmine. When the crystals are oriented similarly, the optical directions coincide exactly with those of epidesmine. As regards the internal twinning structure, numerous crystals from various specimens from the Goose Creek quarry were carefully mounted in balsam, lying on the (010) face and carefully examined in comparison with each other and with fine little stilbites from the Faroes. Although otherwise similar with one another the Goose Creek stilbites varied in degree of visibility of the twinning. In these crystals the extinction ranged from 3°, when the twinning could be discerned, down to 0° when, of necessity, the twinning ceased to exist. There is some "aggregate effect" in the optical behavior, since some crystals which when measured against the edges gave essentially parallel extinction, yielded when crushed, fragments showing extinction inclined up to 5°, measured from the (100) cleavage.

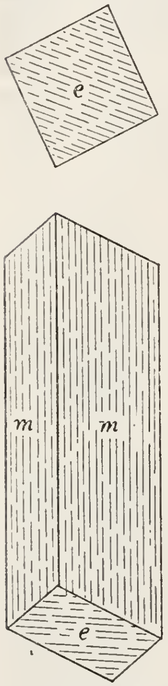


Fig. 26.—Laumontite showing common habit, the unit prism with the negative dome *e* (101).

I am inclined to the belief that "epidesmine" has no right to be considered a distinct species, the material described under that name being merely a variety of stilbite in which the angle of extinction has varied through 5° to zero. The crystallography, cleavages, and optical directions of the two coincide when the elongation is made vertical and the most perfect cleavage is made b (010). Epidesmine, then, may be regarded as orthorhombic stilbite which does not show an anomalous small inclined extinction. The same conclusion has been reached from studying similar crystals from Idaho. Stilbite is best regarded, crystallographically, as orthorhombic, the optical anomalies being disregarded as mere anomalies. In some minerals the dissociation of the crystallography from the optical structure could not be tolerated, but in this case it seems permissible, especially when the cases of some other zeolites are compared.

In the great pile of blasted-down rock in the central portion of the quarry in August, 1923, some of the larger blocks showed surfaces of cracks, sometimes totaling 4 square meters in area, coated with drusy stilbite crystals, somewhat stained by ocherous limonite.

These, in part, rested on practically unaltered basalt and in part upon an earlier druse of small colorless chabazite crystals. The stilbite of these druses is in crystals averaging about 1 mm. in length, which differ from those found in the wider sheared veins in the possession of 4 pyramidal plains as shown in Figure 25. They are thus typical crystals of stilbite. Oriented as drawn with the broadest, pearly-lustered face, as the *b* (010) pinacoid, the measured crystal gave the following angles:

Measurements of stilbite crystal from druse.

Form. No.	Form. Letter.	Symbol. Gdt.	Symbol. Miller.	Quality description.	Measured. φ	Measured. ρ	Calculated. φ	Calculated. ρ
					° ′	° ′	° ′	° ′
1	*b*	0∞	010	Fair, striated	0 00	90 00	0 00	90 00
2	*b*	0∞	010	Poor, blurred	1 43	90 00	0 00	90 00
3		∞0	100	do	88 12	90 00	90 00	90 00
4	*a*	∞0	100	Fair	90 10	90 00	90 00	90 00
5	*p*	1	111	Very poor	45 04	48 35	47 08	48 01
6	*p*	1	111	do	44 23	50 13	47 08	48 01
7	*p*	1	111	Medium	44 14	47 33	47 08	48 01
8	*p*	1	111	Poor	47 30	48 42	47 08	48 01

The lack of agreement in the angles is due to the poor quality of the faces, even the smallest of these stilbites, like the others, exhibiting irregularities showing that they are made up of numerous smaller units not quite in parallel position.

Lying on the *b* (010) face, these crystals, like the simple rectangular ones, give variable very small extinction and some show visible twinning while others do not. The cleavage is almost equally good parallel to (010) and (100). The optical properties are biaxial, negative (−), 2V medium; $r > v$ weak, $\alpha = 1.500$, $\beta = 1.504$, $\gamma = 1.508$, $\gamma - \alpha = .008$; orientation (as drawn) $X \wedge c = 0° - 3°$, $Y = b$, $Z = a$.

Occasionally the stilbite of the druses is overlain by later crystals of calcite.

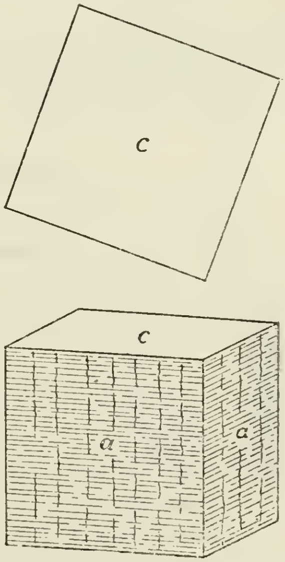
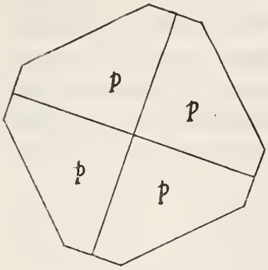


FIG. 27.—APOPHYLLITE OF CUBIC FORM SHOWING ONLY PRISM AND BASAL PINACOID.

LAUMONTITE.

Laumontite is one of the commoner minerals of the locality and was found in a variety of situations. It is all in the form of white prismatic crystals varying from 1 mm. to 1 cm. in length, sometimes in radiating

aggregates. It frequently rests on prehnite, stilbite, and datolite, and is clearly earlier than apophyllite and calcite.



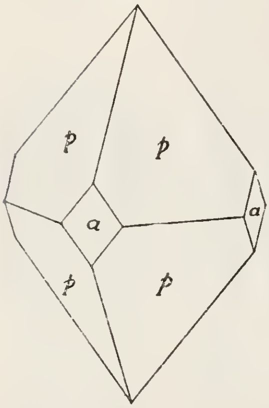


Fig. 28.—Apophyllite showing commonest combination of pyramid with small prism faces.

When first exposed in the quarry the laumontite crystals are water clear and colorless. Upon drying out, however, they become opaque and white from partial dehydration and become very friable, falling to pieces by splitting along the perfect prismatic cleavage. This dehydration tends to swell the crystals so that they do not yield accurate goniometric measurements. They are all simple in habit, the forms being the unit prism, the average angle measured on which was $\phi = 43°$ $15'$ or $\underline{m} \wedge \underline{m}''' = 93° \; 30'$ as compared with $93° \; 44'$, the value given by Dana. The termination is always by an oblique face with angles $\phi = 90° \; 00'$, $\rho = 35° \; 20'$ which indicate that the form is the negative dome *e* $(\bar{1}01)$, the calculated ρ for which is $35° \; 40'$. The habit and appearance of the crystals, which are all vertically striated, are shown in figure 26.

Whitish opaque material which had been exposed to the air of the laboratory for several months was analyzed in the Museum laboratory yielding the following results:

Analysis of laumontite from Goose Creek.

Constituent.	Found.	Theory.
SiO_2	52. 00	51. 1
Al_2O_3	22. 90	21. 7
Fe_2O_3	Trace.	----------
CaO	11. 90	11. 9
MgO	. 26	----------
BaO	Trace.	----------
$H_2O+110°$ C	12. 00	15. 3
$H_2O-110°$ C	1. 44	
Total	100. 50	100. 0

The analyzed material, examined microscopically, was found to be biaxial negative (−), 2V medium, $r < v$ strong, $\beta = 1.515–1.518$. The mineral powders to laths by splitting on the prismatic cleavage and these give extinction varying from 32° to 44°.

OPAL (HYALITE).

Hyalite opal was noted on a single specimen where it coated a joint crack in normal diabase with a thin small botryoidal or globular layer of colorless transparent globules reaching 1 mm. in diameter. This layer is in part overlain by globular calcite.

The hyalite, which is brittle with a conchoidal fracture, is transparent and colorless under the microscope, with a concentric structure. It exhibits a very faint birefringence with a sweeping extinction cross. The index of refraction is variable, between 1.452 and 1.458.

APOPHYLLITE.

Apophyllite, which is an abundant mineral in the veins, occurs in a variety of forms, both as simple crystals and as platy cleavable masses without distinct crystal outlines. Veins solidly filled with the latter may be 3 cm. wide. Sometimes the cleavage surfaces are irregular with a structure resembling the "A" or "feather" structure in mica. Ocassionally platy blades of the apophyllite are arranged radially, giving rosettes up to 2 cm. across.

Pure white apophyllite from a solid vein was analyzed and gave the following results, which are compared with the theoretical composition given by Dana:

Analysis of apophyllite.

Constituent.	Found.	Theory.
SiO_2	51. 80	53. 7
Al_2O_3	. 70	----------
CaO	25. 54	25. 0
MgO	. 56	----------
K_2O	5. 52	5. 2
Na_2O	. 58	----------
H_2O	15. 31	16. 1
F	1. 75	----------
	101. 76	100. 0
Less O–F	. 74	
Total	101. 02	

The apophyllite of the analyzed sample is biaxial positive (+) with 2V very small, r<v strong, $\alpha=\beta=1.534$, $\gamma=1.537$.

In addition to the platy forms apophyllite also occurs as distinct crystals. The simplest of these are tetragonal square prisms terminated by a basal pinacoid, greatly resembling cubes. Some crystals of this type reach 3 cm. in diameter. The largest crystals are dull externally and their outer layer has a pinkish color, although the interiors are transparent and colorless. One specimen shows a narrow vein 1.5 cm. wide with tufts of laumontite crystals grown from either wall and the central portion filled with cleavable apophyllite. Small cavities in this vein contain cubical crystals of apophyllite up to 8 mm. on an edge. The prismatic faces are horizontally striated and the base has a pearly luster. Such crystals are illustrated in figure 27. Some of these are partly coated with minute colorless scalenohedral crystals of calcite.

Many of the smaller apophyllite crystals which are interspersed with or rest upon stilbite crystals are acute pyramidal with the simple habit shown in figure 28, or the slightly more modified habit of Figure 29. Such of the crystals of this type as were measured gave the following average angles:

Measurements of apophyllite crystal, Figure 28.

Form.		Symbol.		Quality description.	Measured.				Calculated.			
No.	Letter.	Gdt.	Miller.		φ		ρ		φ		ρ	
					°	′	°	′	°	′	°	′
1	*a*	0∞	010	Fair	0	00	90	00	0	00	90	00
2	*m*	∞	110	Very poor—very narrow—no signal.								
3	*y*	∞3	130	Fair	18	29	90	00	18	26	90	00
4	New	∞$\frac{3}{5}$	350	Poor	29	46	90	00	30	58	90	00
5	*p*	1	111	Very good....	45	15	60	18	45	00	60	32

The triangular markings on the prisms (130) and (350) are a peculiar feature of the crystals as shown in figure 29. The prism (350) is apparently new but it is not definitely established by these measurements. There is a rounding of the faces of these two prismatic forms and neither gives satisfactory signals.

Translucent small white crystals resting on a crust of prehnite collected by Drs. Merrill and Wherry have the habit shown in figure 30. These gave the following angles:

Measurements of apophyllite, Figure 29.

Form. No.	Form. Letter.	Symbol. Gdt.	Symbol. Miller.	Quality description.	Measured. φ (° ′)	Measured. ρ (° ′)	Calculated. φ (° ′)	Calculated. ρ (° ′)
1	*c*	0	001	Good	....	0 00	....	0 00
2	*a*	0∞	010	Very good....	0 00	90 00	0 00	90 00
3	*y*	∞3	130	Very poor....	18 07	90 00	18 26	90 00
4	*p*	+1	111	Fair	45 12	61 19	45 00	60 32

Apophyllite is frequently observed resting on stilbite and laumontite in such a manner as to show it to be later than both of these. It is thus near the end of the series although earlier than calcite, which was several times seen coating apophyllite crystals. The apophyllite associated with the axinite has been mentioned under that mineral. It was frequently noted that apophyllite crystals associated with the other zeolites were largely dissolved and removed, mere friable skeletons of the crystals remaining.

CALCITE.

Calcite is not an abundant mineral at this locality, although it was found at several places, but nowhere in great amount. It is present in the lot of material from the east-west shear zone collection from the north central part of the quarry face in October, 1922, as numerous crystals up to 5 mm. in length associated with albite, white hornblende, laumontite, etc. These crystals are brilliant, transparent, pale amber colored rhombohedra. They appear to be later than all of the other minerals in the specimens, even the laumontite. The dominant form is the rhombohedron φ· $(\bar{2}\bar{2}41)$ with or without other smaller modifying faces, a typical crystal from this lot having the habit shown in figure 31. This gave the following measurements:

Measurements of calcite crystal, Figure 31.

Form. No.	Form. Letter.	Symbol. Gdt.	Symbol. Miller.	Quality description.	Measured. φ (° ′)	Measured. ρ (° ′)	Calculated. φ (° ′)	Calculated. ρ (° ′)
1	φ·	−2	$\bar{2}\bar{2}41$	Good, blurred.	30 04	62 38	30 00	63 07
2	*p*·	+1	$11\bar{2}1$	Excellent......	30 05	44 31	30 00	44 36
3	*m*·	+4	$44\bar{8}1$	Medium	30 07	75 43	30 00	75 47
4	------	+52	$52\bar{7}1$	Poor..........	16 03	75 43	16 06	74 18

Crystals of similar form, size, and color but etched and dull were found in April, 1923, in a north-south vein near the north end of the quarry face, associated with datolite, prehnite, and laumontite, and definitely later than all of these.

Crystals of similar habit but smaller and of a greenish color were seen overlying chabazite druses on horizontal cracks in diabase near the southwest corner of the quarry.

The stilbite crystals showing pyramid planes which form broad limonite stained druses on basalt are often overlain by calcite crystals which are either scalenohedral or rhombohedral in habit. Some of these are minute but others, of flattened rhombohedral form, reach 1 cm. in greatest dimension and some obscure flattened crystals of hexagonal outline are 3 cm. across.

One translucent white calcite crystal 3 mm. long, which rested upon prehnite, had the habit shown in figure 32 and gave the following angles:

Angles of calcite crystal, Figure 32.

Form.		Symbol.		Quality description.	Measured.		Calculated.	
No.	Letter.	Gdt.	Miller.		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	φ'	−2	$\bar{2}\bar{2}41$	Poor, rounded	30 49	64 49	30 00	63 07
2	Γ'	−3	$\bar{3}\bar{3}61$	Fair, rounded	29 40	71 37	30 00	71 20
3	m'	+4	$44\bar{8}1$	Very good	30 00	75 46	30 00	75 47
4	-----	−32	$\bar{3}\bar{2}51$	Medium	24 20	68 43	23 25	
5	U:	13. 1	$13.\ 1.\ \bar{14}.\ 1$	Fair	3 28	82 30	3 40	82 36

Calcite occurs also as indistinct radial fibrous globular masses overlying a small botryoidal crust of opal on a specimen of ordinary basalt. The globular patches of calcite reach a diameter of 5 mm.

GALENA.

Galena is a rare constituent of the zeolite-bearing vein fillings but was noted several times, as small isolated crystals with perfect cubic cleavage. It was found embedded in chlorite, in prehnite, one of the earlier minerals, and in apophyllite, one of the latest minerals of the veins.

CHALCOPYRITE.

Chalcopyrite is also rare in the later veins, being comparable with galena in this respect. Like galena it was noted in isolated crystals inclosed in prehnite and in apophyllite. It is much more common

in the pegmatitic rocks, both the normal diabase pegmatite and the albitic rocks where it forms grains and crystals in porous spots or small miarolitic cavities. It is also of frequent occurrence embedded in diopside in diopside-filled seams.

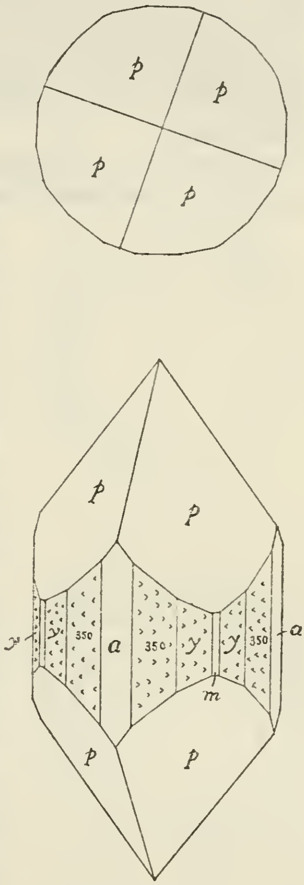


FIG. 29.—APOPHYLLITE SHOWING COMBINATION OF PYRAMID WITH FACES OF FOUR PRISMS.

SPHALERITE.

How rare sphalerite is may be adduced from the fact that only a single grain of this zinc sulphide was found in all of the specimens collected. This grain, which was about 2 mm. in diameter, possessed good cleavage and was vivid greenish yellow in color. It was embedded in a broad cleavage surface of apophyllite and was obviously contemporaneous with the apophyllite.

PARAGENESIS.

The minerals observed in the secondary deposits in the veins occur, usually, in groups of from one to three or four in any given specimen and the relative ages can only be adduced by a process of fitting together the evidence derived from a study of a large number of specimens. Overlapping sequences were not proven to occur and it is assumed, tentatively, that all of the minerals belong to a single series. This series, as well as it can be worked out, is as follows, beginning with the earliest cavity-filling mineral:

1. Albite.
2. Chlorite.
3. Hornblende (asbestiform).
4. Epidote (hour-glass).
5. Axinite.
6. Quartz.
7. Prehnite.
8. Datolite.
9. Chabazite.
10. Stilbite.
11. Laumontite.
12. Opal (hyalite).
13. Apophyllite.
14. Calcite.

The position of albite is rather definitely fixed by its occurrence underlying both chlorite and hornblende.

Chlorite is in most cases a very early mineral although it may also occur as a later deposit.

The asbestiform hornblende definitely underlies laumontite and stilbite in one specimen, but on another, fibers seem to penetrate albite crystals, and in still another it appeared to rest upon prehnite. Fibers of hornblende of this type were also seen inclosed in albite in a thin section of the albitic pegmatite and it may precede albite in formation or, more probably, its deposition extended over a considerable range.

Epidote of the hour-glass type was seen imbedded in chlorite in asbestiform hornblende, and in prehnite, so that it is apparently contemporaneous with all of these. Prismatic crystals associated with the axinite are about contemporaneous with the latter and the accompanying hornblende.

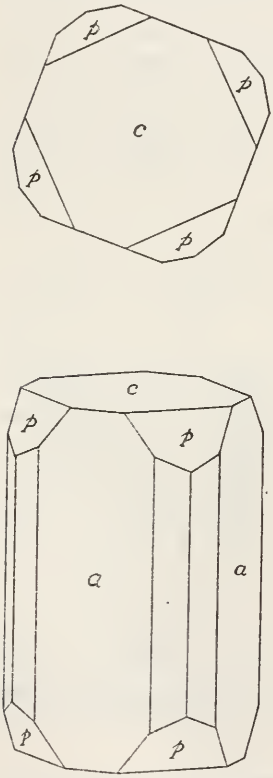


Fig. 30.—Apophyllite from specimen of Merrill and Wherry showing two prisms, pyramid and base.

Axinite was found in circumstances which indicate it to be later than diopside, contemporaneous with hornblende and epidote and earlier than apophyllite.

Quartz was seen in only one specimen where it was later than chlorite and distinctly earlier than datolite.

Prehnite is apparently about contemporaneous with the last of the epidote and is earlier than some datolite and later than other datolite crystals, on which it forms an overlying crust. This is considered to indicate two generations of datolite.

Datolite has been mentioned in its relation to prehnite. It was distinctly earlier than stilbite.

Chabazite occurred only on joints and was not associated with any earlier mineral, but is distinctly older than the overlying stilbite.

Stilbite is clearly younger than chabazite in some specimens, and older than laumontite in others. It was seen to be younger than datolite and prehnite.

Laumontite is definitely younger than stilbite and as definitely older than apophyllite.

Opal (hyalite) is known only to be older than calcite. Its placing in the table is thus arbitrary.

Apophyllite is definitely younger than stilbite and laumontite, and is clearly older than calcite which often forms pseudomorphs after apophyllite crystals.

Calcite is, so far as observed, the youngest mineral of the veins.

The sulphides, which include galena, chalcopyrite, and sphalerite, are of uncertain position and are not included in the above table. Galena was observed included in, and apparently contemporaneous with, chlorite, prehnite, and apophyllite, which would seem to indicate that it was deposited at three different times. Chalcopyrite was found included in prehnite and apophyllite, and sphalerite in apophyllite.

ORIGIN OF THE ZEOLITES AND ASSOCIATED MINERALS.

There is a continuous sequence of events from the close of the magmatic period, marked by consolidation of albitic rocks, and the deposition of the zeolites. Where the solutions were confined at the final consolidation the albite rocks contain miarolitic cavities in which were deposited, in addition to the lining of quartz and albite, diopside, chalcopyrite, byssolitic hornblende, epidote, and chlorite. Moreover, the reactions of these solutions on the adjacent pegmatites produced, in the first stage, diopside from augite, albite from plagioclase, and titanite by the replacement of magnetite. At a later stage the diopside was replaced by fibrous hornblende.

In the most common type of hydrothermal alteration along the diopsidizing seams, the reactions of the solutions upon the previously consolidated normal diabase forming the walls of the crack are the same, namely, albitization of the plagioclase, followed by sericitization, diopsidization of the augite and replacement of the magnetite by titanite. In the open space of the central crack the minerals deposited were diopside with less chlorite and titanite and, rarely, axinite.

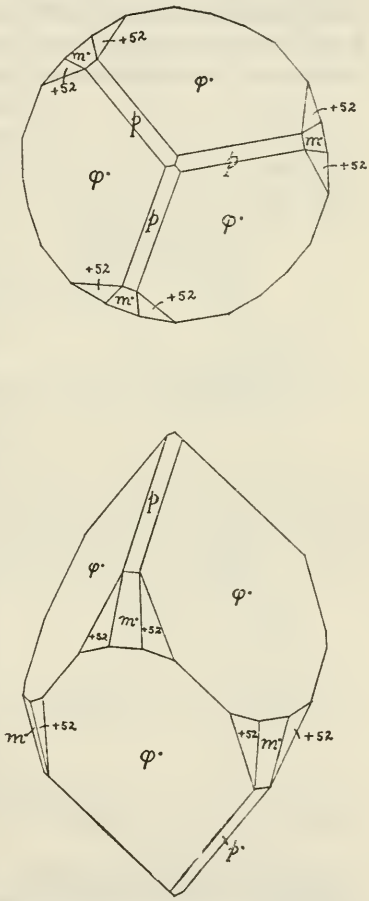


Fig. 31.—Calcite showing the commonest habit of amber colored calcite occurring in the veins.

No definite line can be drawn separating the thin seams accompanied by hydrothermal alteration, from the miarolitic cavities on the one hand and from the zeolite bearing veins on the other. The

sequence of minerals in the zeolite assemblage from first to last probably resulted from gradual decrease of temperature and pressure away from the source of the solutions. Toward the end of the series the solutions apparently had lost their vigor and exercised only a mild alteration effect upon the rock intersected by the sheared zones, with some kaolinization and sericitization of the feldspar and staining of the pyroxene by chloritic material. There can exist no reasonable doubt that the agency which deposited all of the vein minerals was water and that this water was magmatic, the final product of the consolidated diabase, ascending (or traveling laterally) through fissures in the previously consolidated material.

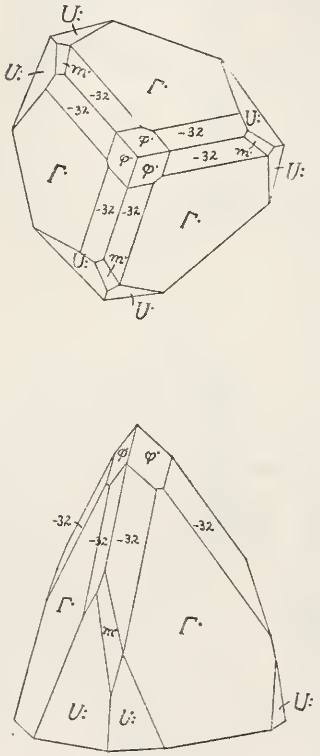


FIG. 32.—CALCITE. HABIT OF A SINGLE WHITE CRYSTAL OBSERVED RESTING ON PREHNITE.

This conclusion is in entire agreement with the excellent statement of Lewis [27] of the mode of origin of the zeolites and associated minerals of the New Jersey localities.

In the quarry at Goose Creek the only veins seen are contained in the parent diabase. In a quarry at Leesburg in limestone immediately above the sill the veins penetrate the Triassic limestone fanglomerate and have deposited much calcite and datolite with some barite, apophyllite, etc. The minerals of this Leesburg quarry are to be described in another paper which is now in preparation; a third paper in the series will describe the phenomena observed at Dickerson, Maryland, where the diabase has penetrated and altered Triassic shale.

The total net effect of the hydrothermal alteration of the normal diabase can not be definitely arrived at in the absence of an analysis of the altered material. The effect along the diopside seams probably has been a considerable addition of soda with removal of lime and iron. It seems probable that the alkalies and at least part of the silica were originally contained in the solutions but the later minerals of the series in the veins may in large part be made up of materials extracted from the adjacent rock. Thus much of the lime of the apophyllite, prehnite, datolite, and

[27] J. Volney Lewis. Origin of the secondary minerals of the Triassic trap rocks. New Jersey Geol. Survey Bull. 16, Ann. Rept. for 1914, pp. 45–49, 1915.

zeolites probably was not originally present in the solutions but was derived from the plagioclase of the altered rock by substitution of soda. The boric acid of the datolite and axinite, the sulphur of the chalcopyrite and pyrite, and the fluorine entering the apophyllite near the end of the series were doubtless from the magma.

It appears then that the solutions were rich in soda in some form, possibly combined with silica in solution, and contained appreciable amounts of boric acid, sulphur, and fluorine. Bailey and Grabham[28] have considered that the solutions forming the end product of cooling of a basaltic magma are richly charged with sodium carbonate in solution. Such a solution might be capable of producing all of the effects here described, although one objection to assuming the soda in the solutions at the Goose Creek locality to have been in the form of carbonate is the very limited amount of calcite there found.

EXPLANATION OF PLATES.

Plate 1.

Diabase pegmatite intrusive as a tabular body in ordinary diabase. $\frac{9}{10}$ natural size.

Plate 2.

Upper: Aplite dike in contact with normal diabase. The aplite is cut by later cracks of two ages, the first filled with diopside and the second (along which the specimen is broken) filled with laumontite. $\frac{9}{10}$ natural size.

Lower: Hand specimen of diabase pegmatite showing long blades of augite with diallagic parting, etc. $\frac{9}{10}$ natural size.

Plate 3.

Diabase pegmatite in ordinary diabase, cut by later seam along which hydrothermal alteration has changed the augite to hornblende, etc. $\frac{9}{10}$ natural size

Plate 4.

Upper: Photomicrograph of ordinary diabase showing structure, outlines and cleavage of augite and irregular form of iron ore. Ordinary light. Magnified 13 diameters.

Lower: Diabase pegmatite showing large augites, feldspars partly replaced by sericite, and interstitial micropegmatite. Ordinary light. Magnified 13 diameters.

Plate 5.

Upper: Diabase pegmatite cut by a seam along which hydrothermal deposition of hornblende has taken place. The black portion of the field is hornblende with some chlorite. The gray is altered feldspar and the white is quartz. The section shows the replacement of altered feldspar of micropegmatite by hornblende giving quartz-hornblende micrographic intergrowths. To the right at the bottom of the picture is an area of hornblende which still contains a core of unreplaced augite. Ordinary light. Magnified 13 diameters.

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[28] E. B. Bailey and G. W. Grabham. Albitization of basic plagioclase feldspars. Geol. Magazine, vol. 6, pp. 250–256, 1909.

Lower: Diabase pegmatite—somewhat altered. The most conspicuous feature of the field is the large skeletal growth of iron ore largely confined to an altered pyroxene crystal. The interstices of the iron ore are filled with secondary biotite and the feldspar of the micropegmatite at the bottom of the plate is largely replaced by biotite and hornblende. Ordinary light. Magnified 13 diameters.

PLATE 6.

Albitic pegmatite in normal diabase, showing feathery albite-diopside micrographic intergrowths. $\frac{9}{10}$ natural size.

PLATE 7.

Upper: Photomicrograph of the analyzed albitic pegmatite. The plate shows the characteristic composition and structure of the rock. The large gray prismatic grains and the gray material of the micropegmatite is albite. A spear-shaped prism pointing downward from the top of the photograph to the left of the center is diopside and this connects with an intergrowth of diopside and albite. Ordinary light. Magnified 13 diameters.

Lower: An albitic pegmatite devoid of quartz and micropegmatite. The clear mineral is colorless diopside and the gray is kaolinized albite. The large irregular dark areas in the section are skeleton magnetites largely replaced by titanite and filled with chlorite. Ordinary light. Magnified 13 diameters.

PLATE 8.

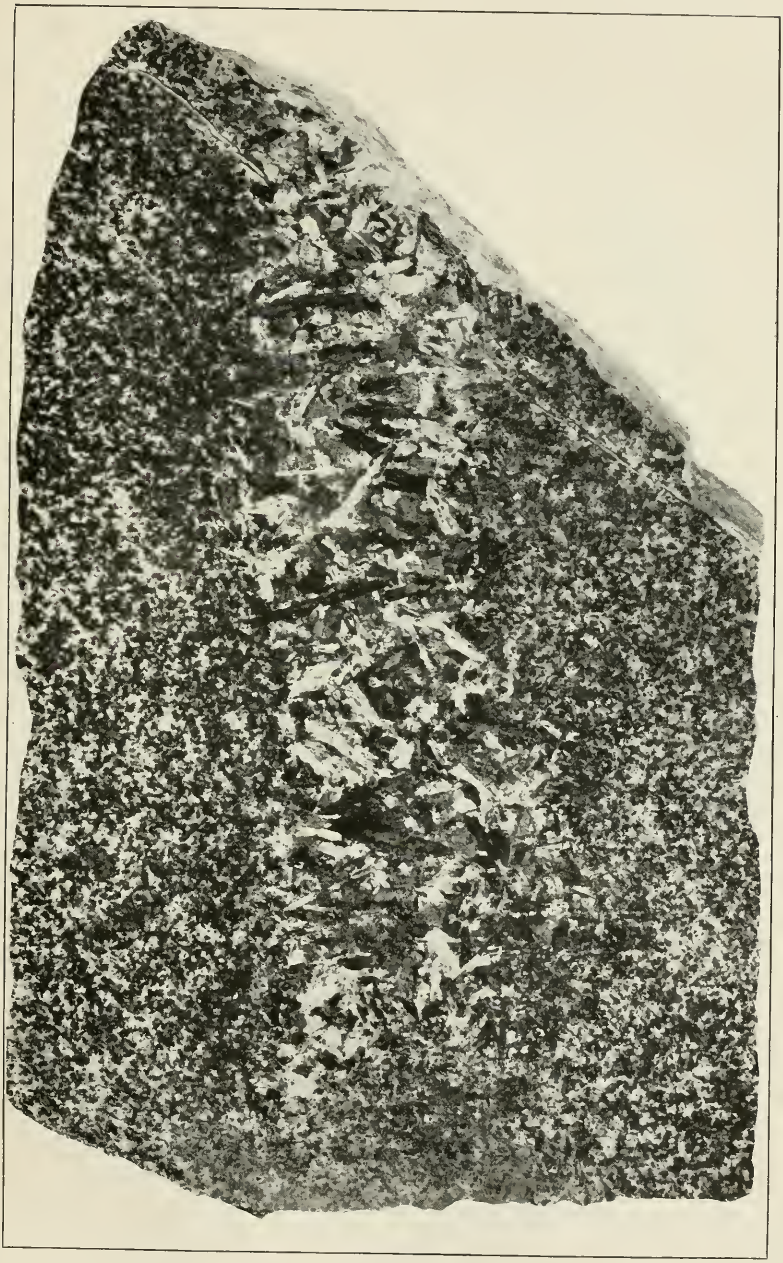
Albitic pegmatite grading into diabase pegmatite. Shows long blades of diallagic augite. At the lower end of the specimen the groundmass is largely plagioclase but the feldspar of the balance is albite. The long pyroxene blades are replaced along their borders and at the tips by diopside. $\frac{9}{10}$ natural size.

PLATE 9.

Upper: Micropegmatite in patches growing out from the wall (left) toward the granular center of the analyzed aplite dike. Ordinary light. Magnified 13 diameters.

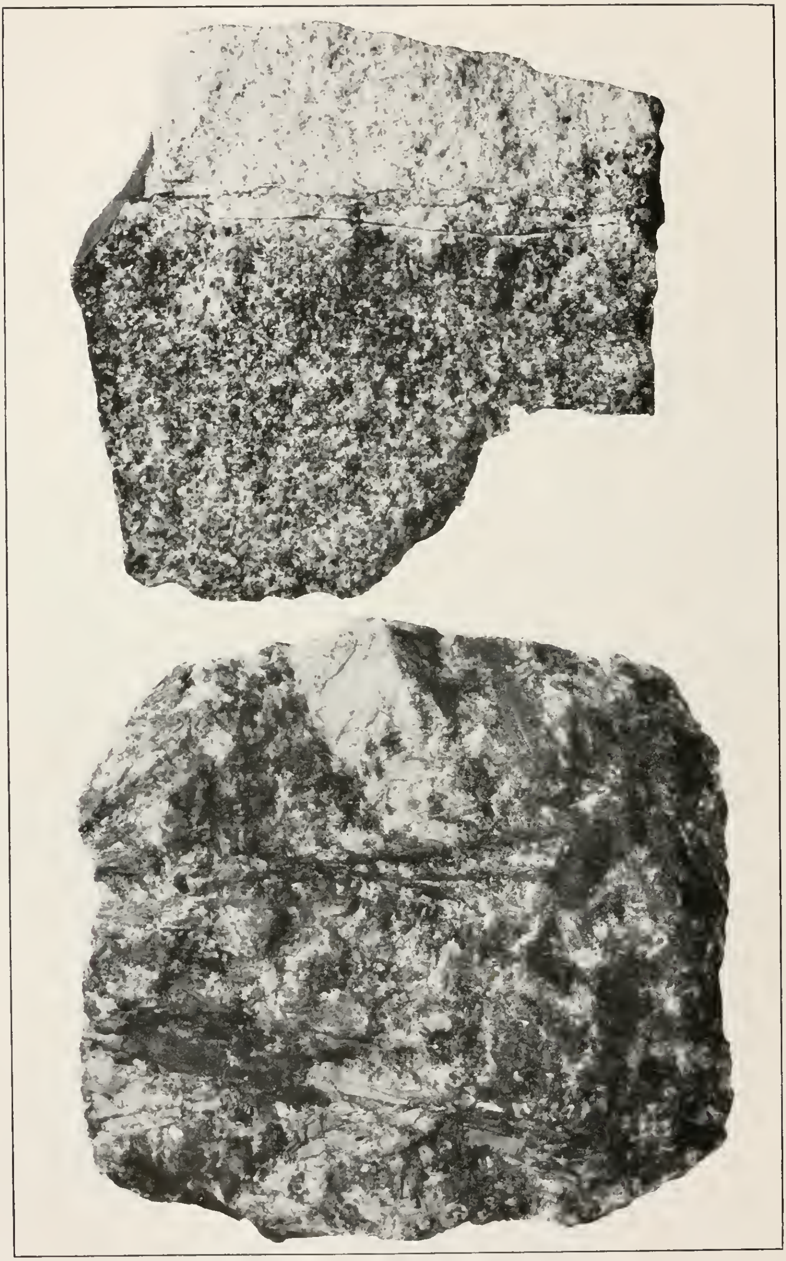
Lower: Albitic pegmatite from wall of the mass illustrated in Plate 6. Ordinary light. Magnified 13 diameters.

O



Diabase Pegmatite in Diabase

For explanation of plate see page 85

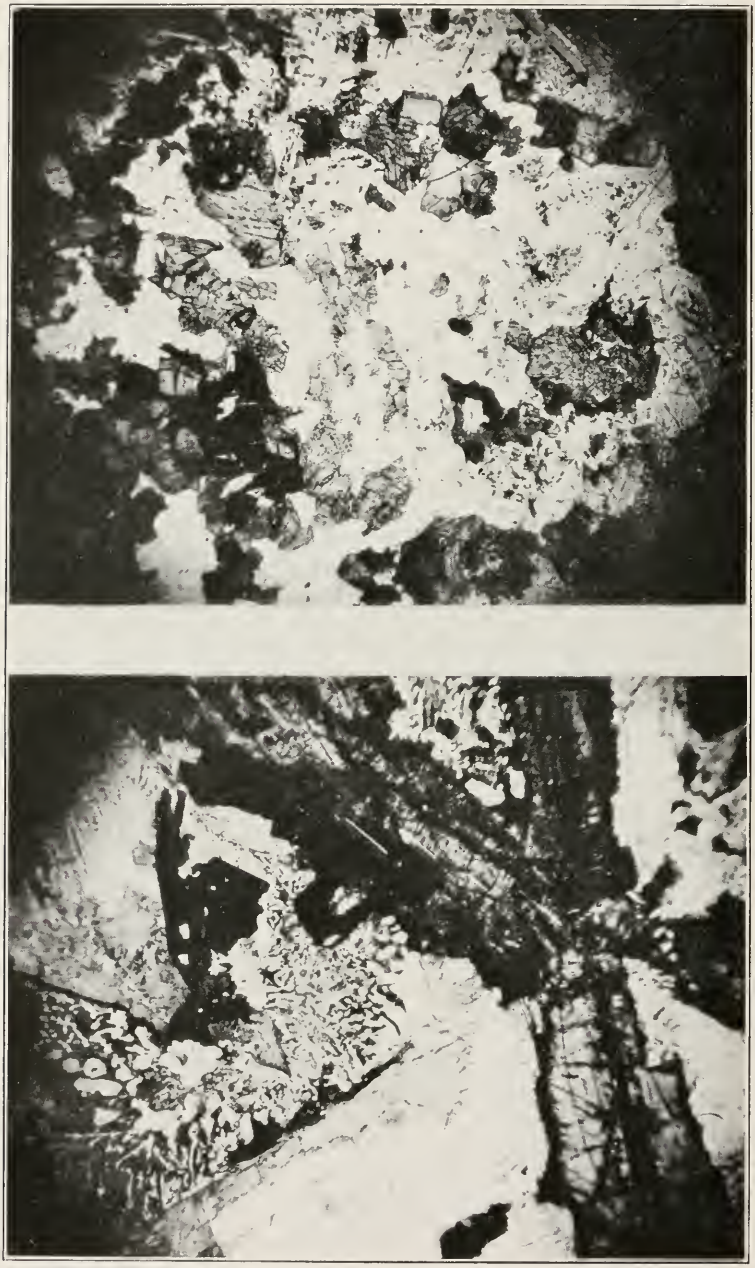


APLITE, DIABASE, AND DIABASE PEGMATITE

FOR EXPLANATION OF PLATE SEE PAGE 85

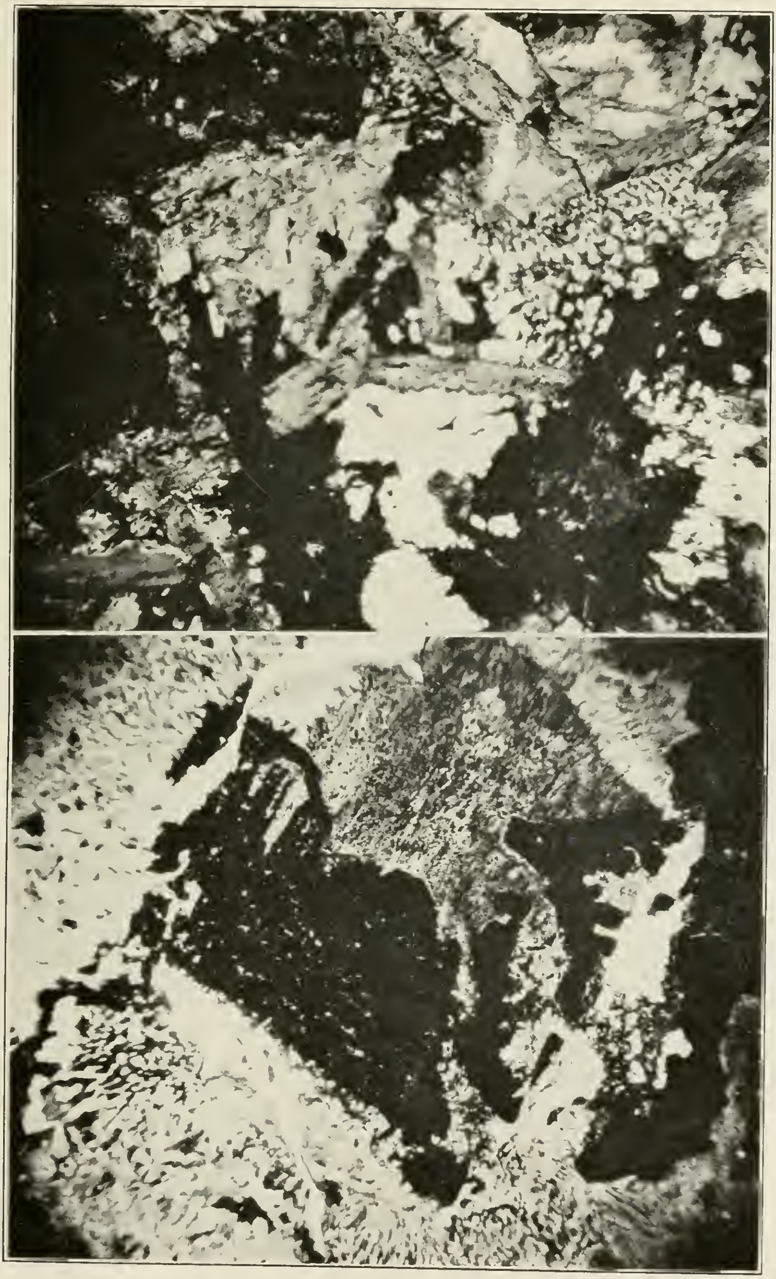
DIABASE AND DIABASE PEGMATITE CUT BY HORNBLENDIZING SEAM

FOR EXPLANATION OF PLATE SEE PAGE 85



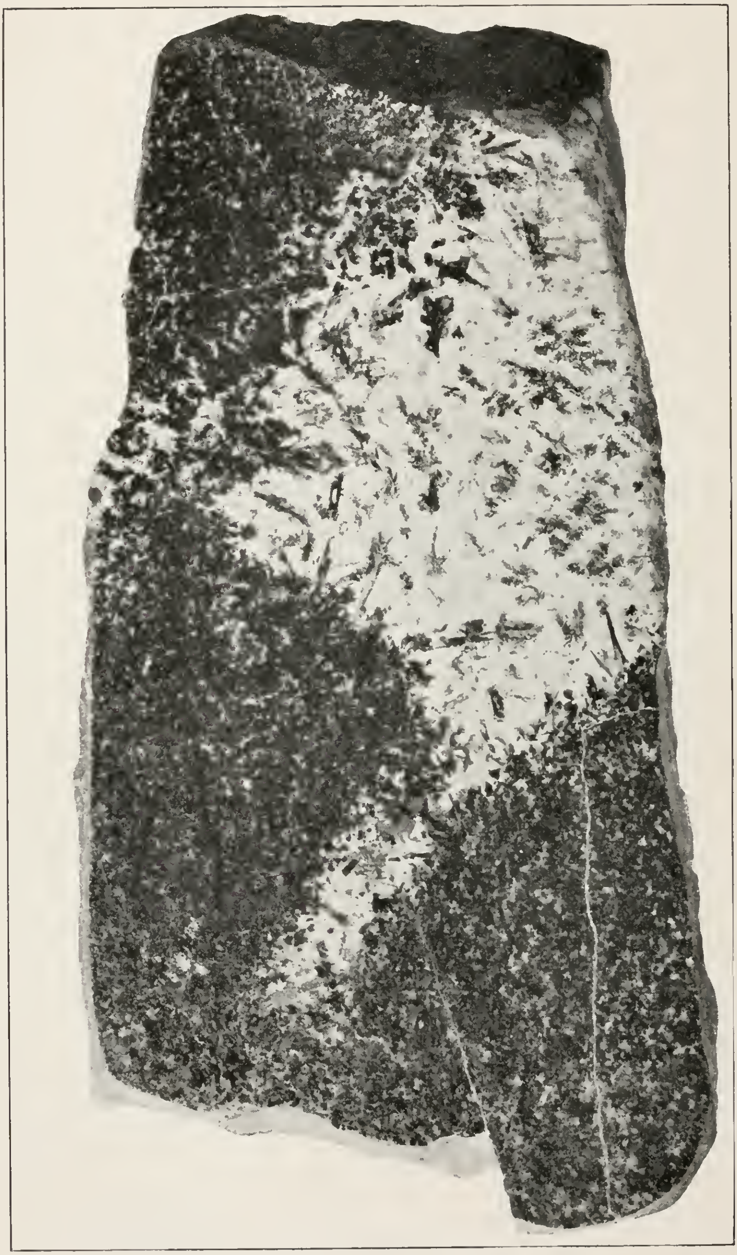
Photomicrographs of Diabase and Diabase Pegmatite

For explanation of plate see page 85



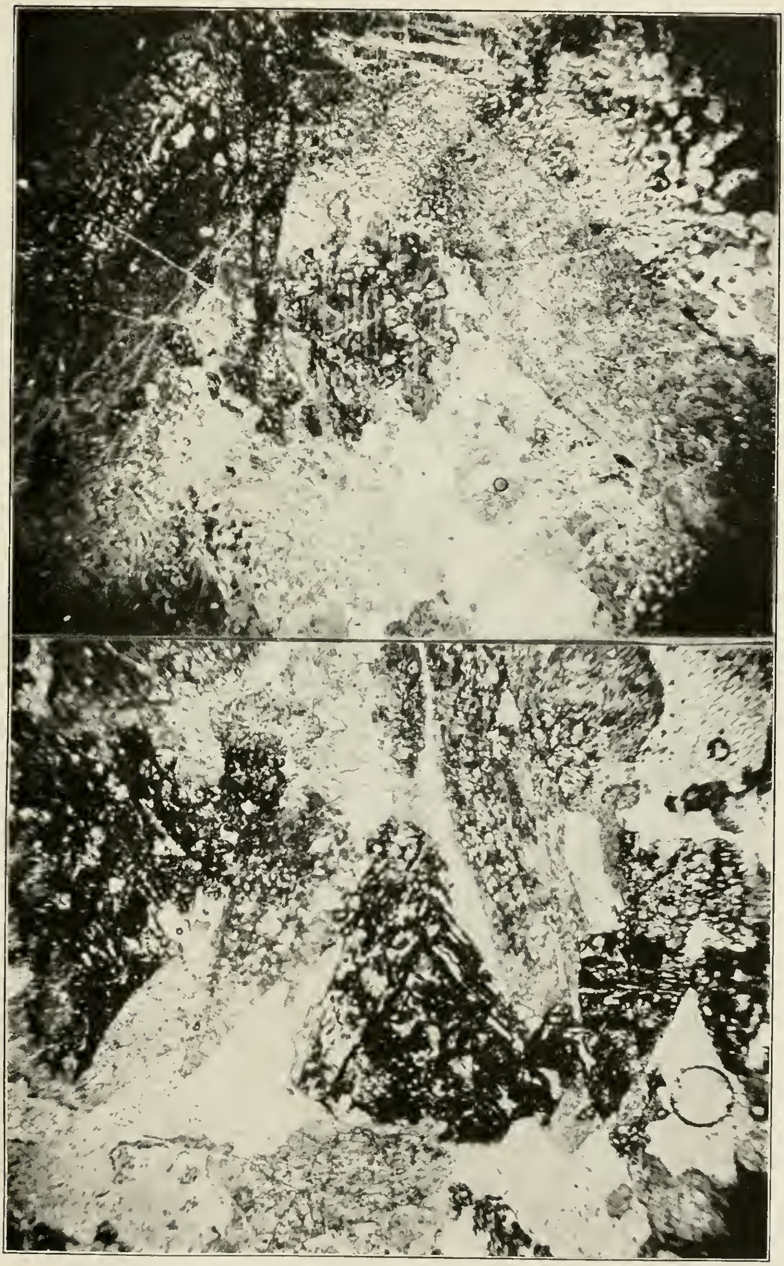
PHOTOMICROGRAPHS OF DIABASE PEGMATITE

FOR EXPLANATION OF PLATE SEE PAGES 85 AND 88



Albitic Pegmatite in Diabase

For explanation of plate see page 86

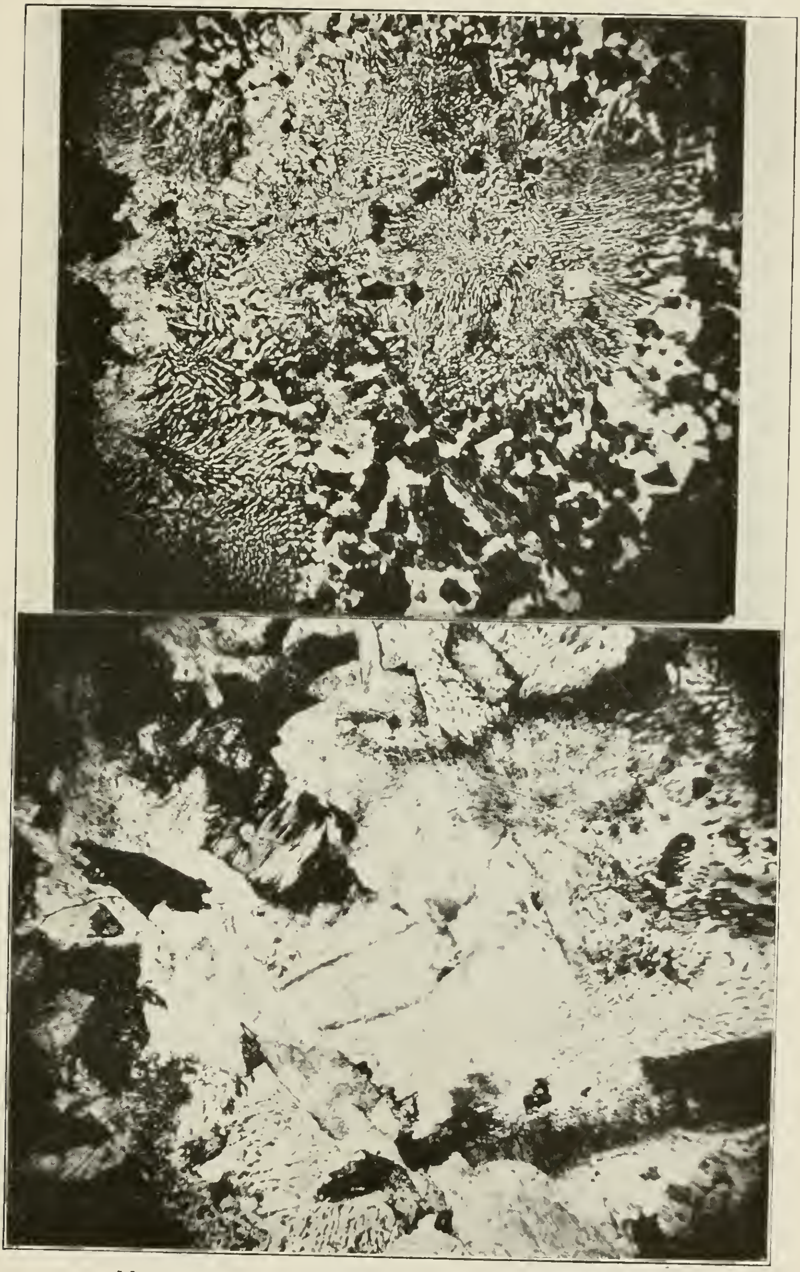


PHOTOMICROGRAPHS OF ALBITIC PEGMATITE

FOR EXPLANATION OF PLATE SEE PAGE 86

AUGITE BLADES IN DIABASE PEGMATITE

FOR EXPLANATION OF PLATE SEE PAGE 86



MICROPEGMATITE IN APLITE AND ALBITE PEGMATITE

FOR EXPLANATION OF PLATE SEE PAGE 86

DESCRIPTIONS OF NEOTROPICAL TWO-WINGED FLIES OF THE FAMILY DROSOPHILIDAE.

By J. R. Malloch,

Of the Biological Survey, United States Department of Agriculture.

In this paper are presented descriptions of a number of new species and notes on one or two previously described species of Drosophilidae represented in the collection of the United States National Museum.

The species of *Stegana*, except two, were briefly diagnosed in a synoptic key printed in the Entomological News [1] and the present descriptions are given to furnish details not included in that paper, as well as to place upon record the type-numbers and other data not included therein.

The types collected by Borgmeier, Wetmore, and Holt are deposited in the National Museum with the others, those of the first collector being sent to the author by the collector, of the second being found in the collection of the Biological Survey, and of the third from W. L. McAtee.

STEGANA NIGRITA Malloch.

Male and female.—Brownish black, shining. Antennae, and sometimes the humeral angles, part of scutellum, sides of abdomen at base, and upper margin and middle of pleura paler brown, the pleura never whitish yellow in center and the upper and lower vittae never conspicuously darker than the other parts of pleura. Legs pitchy black, usually with apices of tibiae and all of tarsi whitish yellow, sometimes the tibiae but little darkened. Wings brown, paler along hind margin. Halteres brown.

Frons at anterior margin not over one-half as wide as its length, and about three-fourths as wide as at vertex; eyes about one-fourth higher than long; cheek linear; face not carinate above; antennae extending to mouth; palpi broad. Scutellum slightly pointed, apical bristles about three-fourths as long as basal pair. Inner cross-vein at middle of discal cell; marginal cell obtuse at apex; fourth vein

[1] Ent. News, pp. 96–100, 1924.

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gradually approaching third on apical section; apex of fifth vein deflected.

Length, 2–3 mm.

Type, and 10 paratypes, Higuito, San Mateo, Costa Rica (P. Schild).

Type.—Male, Cat. No. 26684, U.S.N.M.

STEGANA ATRIMANA Malloch.

Female.—Head testaceous yellow, ocellar region fuscous, cheek silvery white; antennae yellow, third segment mostly black; palpi yellow. Thorax yellowish brown, whitish at humeral angles and in center of pleura, the upper pleural vitta and one below middle distinct, mesonotum not vittate. Abdomen shining fuscous. Legs pale tawny yellow, apices of fore femora, fore tibiae from near bases to near apices, and basal four segments of fore tarsi black, mid and hind femora largely brown, tibiae more or less brownish basally. Wings brown, subhyaline along hind margin. Knobs of halteres brown.

Eye fully as long as high; cheek about half as high as width of third antennal segment; facial carina very low; antennae extending to mouth. Scutellum shorter than usual, apical bristles about half as long as basal pair; each humeral angle with one bristle. Inner cross-vein at middle of discal cell; fifth vein deflected at outer cross-vein.

Length, 2–2.5 mm.

Type and two paratypes, Higuito, San Mateo, Costa Rica (P. Schild).

Type.—Male, Cat. No. 26683, U.S.N.M.

STEGANA CURVIPENNIS Fallen.

Confined to North America and Europe. In National Museum collection.

STEGANA INTERRUPTA, new species.

Female.—Head stramineous; frons with a large spot on anterior margin and another on ocellar region connected by a black line, with an hour-glass shape; apex of third antennal segment, vibrissal angle, sides of labrum, and apices of palpi deep black; upper half of occiput fuscous, lower half, orbits and cheeks silvery white. Thorax tawny yellow, whitish on humeral angles and middle of pleura, with two broad brown, poorly defined discal vittae which are most distinct anteriorly, a V-shaped black mark which has its apex below prothoracic spiracle, one arm running upward in front of wing base on to disc, and the other extending along middle of pleura to base of haltere; a second fuscous vitta over lower part of pleura; disk

of scutellum brown. Abdomen brown, apices of tergites blackish. Legs tawny, fore coxae, and the greater part of all femora and tibiae fuscous. Wings brown, paler towards hind margins, and with a very small subhyaline spot beyond outer cross-vein. Knobs of halteres dark brown.

Eye higher than long; cheek less than half as high as width of third antennal segment, the latter extending to slightly below mouth margin. Each humeral angle with one bristle; scutellum almost semicircular, apical bristles half as long as basal pair. Inner cross-vein at middle of discal cell; last section of fourth vein slightly curved; last section of fifth not abruptly deflected at outer cross-vein, rather curved downward.

Length, 3.25 mm.

Type and one paratype, Higuito, San Mateo, Costa Rica (P. Schild).

Type.—Female, Cat. No. 26678, U.S.N.M.

The type specimen has a white egg protruded from apex of abdomen. The portion which is visible is shaped like a flat-bottomed boat, the margins near upper side carinate and with a fringe of pale closely placed hairs.

STEGANA TEMPIFERA Malloch.

Male and female.—Head yellow testaceous, frons with an hour-glass shaped dark mark as in *interrupta*, but not so distinct, sometimes only brownish; face with two narrow dark cross-bands, one below bases of antennae and the other above mouth; labrum brown; palpi mostly fuscous; cheek pale yellow; upper occiput brown. Thorax tawny yellow, whitish yellow on pleura, disk with three partial brown vittae, one on lateral margin, another just above it from anterior margin, and another mesad of that which does not extend as far forward. Abdomen dark brown, sides of some of the basal tergites yellowish. Legs testaceous yellow, fore femora with a basal and an apical brown band, nearly all of mid and hind femora and a broad median band on same tibiae dark brown, fore tibiae with a faint median ring. Wings brown, paler towards hind margins. Halteres yellow.

Eye about as long as high: cheek nearly linear. Scutellum slightly pointed, apical bristles about two-thirds as long as basal pair. Inner cross-vein at or close to middle of discal cell; last section of fourth vein not absolutely straight, very close to third at apex; fifth vein deflected at outer cross-vein

Length, 2.5 mm.

Type and four paratypes, Higuito, San Mateo, Costa Rica (P. Schild).

Type.—Male, Cat. No. 26680, U.S.N.M.

STEGANA FLAVIFRONS Malloch.

Female.—Head yellow, ocellar region and palpi fuscous, sides of labrum and third antennal segment brown. Thoracic dorsum brown, paler along anterior margin and without distinct vittae; pleura pale yellow, upper black vitta conspicuous, lower one absent or present only on upper margin of sternopleura. Abdomen blackish brown, sides of some of basal tergites yellowish. Legs pale yellow, fore femora with a large apical blackish spot, fore tibiae with black apices, basal segment of fore tarsi black or brown; mid and hind femora nearly all blackish brown, bases of mid tibiae and middle of hind pair broadly brown. Wings brown, paler along hind margin. Halteres yellow.

Eye higher than long; frons at anterior margin about half as wide as its length; cheek linear; palpi broadened; antennæ extending to mouth. Scutellum almost rounded, apical bristles about two thirds as long as basal pair. Fore metatarsus dilated. Wing as in last species.

Length, 2.5–3 mm.

Type and paratype, Higuito, San Mateo, Costa Rica (P. Schild).

Type.—Female, Cat. No. 26679, U.S.N.M.

STEGANA MAGNIFICA Hendel.

This species, originally described from Peru, is not present in the available material. The data presented in the key should enable students to identify it.

STEGANA PLANIFACIES Malloch.

Female.—Frons glossy black, yellowish only on sides below proclinate orbital bristle and at anterior lateral angle; middle of face broadly black on entire width; palpi yellow; cheeks silvery white; occiput blackish on upper half and with a black spot at level of pleural vitta; third antennal segment almost entirely black. Thorax brownish black on disk, paler on anterior and lateral margins, but not distinctly vittate; scutellum black, with a conspicuous white central vitta, broadest posteriorly; upper pleural vitta complete. Abdomen black, paler on sides at base. Legs pale yellow, apical spot of fore femora faint; mid and hind femora each with an oblique fuscous streak on anterior side from near middle to near apex, that on hind pair least distinct; mid and hind tibiæ or at least the mid pair with a basal fuscous band. Wings brown, almost hyaline along hind border. Halteres obscurely yellow.

Eye longer than high; frons wider than in last species, especially at vertex; cheek almost as high as width of third antennal segment; palpi broad; antennae extending to mouth; face not carinate above. Scutellum very little pointed, apical bristles about two-thirds as

long as basal pair. Fore tarsus slender. Wing a little narrower than usual; discal cell not as wide at apex as at inner cross-vein, the latter noticeably in front of middle of cell; fifth vein continued straight beyond outer cross-vein for about half the length of latter, then rather abruptly deflected, the section beyond cross-vein distinctly longer than the latter; last section of fourth vein not entirely straight.

Length, 3 mm.

Type and paratype, Higuito, San Mateo, Costa Rica (P. Schild).

Type.—Female, Cat. No. 26682, U.S.N.M.

In this and the following four species each humeral angle has two distinct bristles, except in *coleoptrata* which has the second bristle either minute or absent. Hendel in describing *magnifica* did not mention the humeral bristle, but it very probably is present in duplicate as in the others.

STEGANA ATRIFRONS Malloch.

Female.—Similar to the last species, but the frons and scutellum are entirely black, the mid and hind femora are black on apical half and the tibiae of these legs are broadly blackened basally.

The face has a sharp carina on upper half in center, the inner cross-vein is at middle of discal cell, the wing is broader as is also the discal cell, and the outer cross-vein is at its own length from apex of fifth vein, while the latter is deflected closer to the cross-vein. Last section of fourth vein appreciably curved.

Length, 2.5 mm.

Type, Higuito, San mateo, Costa Rica (P. Schild).

Type.—Female, Cat. No. 26681, U.S.N.M.

STEGANA SCHILDI Malloch.

Male and female.—Head pale yellow, frons with ocellar region fuscous, and the anterior third glossy black; face with a narrow transverse band of black below base of antennae; third antennal segment almost entirely black; palpi and labrum yellow; upper occiput fuscous, a black spot in line with anterior extremity of pleural vitta; cheeks silvery white. Mesonotum with six brown vittae, in part fused; scutellum dark brown, usually with a rather faint median pale line. Abdomen black, paler on sides at base. Legs pale yellow, fore pair with a pale brown spot at apices of femora on anterior side; mid legs with apical half of femora, except extreme apices, dark brown, and bases of tibiae rather broadly brown; hind femora pale brown on anterior side on almost their entire length, hind tibiae sometimes faintly brown basally. Wings brown, paler towards hind margin. Halteres yellow.

Anterior width of frons much greater than half the median length of same; third antennal segment extending below mouth margin;

head otherwise as in last species. Apical scutellar bristles about half as long as basal pair. Inner cross vein at or a little in front of middle of discal cell, and at about its own length from apex of fifth vein; last section of fourth vein noticeably curved.

Length, 3–4 mm.

Type, male, allotype, and five paratypes, Higuito, San Mateo, Costa Rica (P. Schild).

Type.—Male, Cat. No. 26674, U.S.N.M.

Named in honor of the collector.

STEGANA UNIFORMIS Malloch.

Male and female.—Head pale yellow; frons with a large black mark on ocellar region which extends to middle of frons but not to lateral margins, and the anterior third glossy black; face with a broad transverse black band below bases of antennae; occiput fuscous on upper half, and with a black spot in line with the pleural vitta; cheek silvery white; third antennal segment black except at base; palpi and labrum yellow. Dorsum of thorax with three broad black vittae on a yellow ground, the median one broadened posteriorly; scutellum blackish brown; pleura with a complete black vitta above. Abdomen black. Legs yellow, fore femora with an apical black spot on anterior side, mid and hind femora with apices black, mid pair most conspicuously so; tibiae of same legs brown at bases. Wings brown, paler along hind margin. Halteres yellow.

Head as in *schildi*, frons about half as wide at anterior margin as its median length; face not two thirds as high as back of head; antennae extending to mouth; cheek as high as width of third antennal segment. Both humeral bristles long; apical scutellar bristles about two-thirds as long as basal pair. Inner cross vein at about one-third from base of discal cell; last section of fourth vein parallel to third on its basal half, then curved forward towards third; outer cross vein at about its own length from apex of fifth.

Length, 4–4.5 mm.

Type, Higuito, San Mateo, Costa Rica (P. Schild). Paratype, Erwin Island, Panama Canal Zone, July 18, 1923 (R. C. Shannon).

Type.—Female, Cat. No. 26675, U.S.N.M.

STEGANA COLEOPTRATA Scopoli.

The humeral angles each have one bristle. Occurs in North America and Europe.

STEGANA (ORTHOSTEGANA) ACUTANGULA Hendel.

This species was used as the genotype of *Orthostegana* by Hendel. As in the preceding five species the humeral bristle is duplicated, but the head is more like that of *curvipennis*, the eye being much higher than long. The microscopic erect hairs on the interfrontalia

distinguish it from the species of *Stegana*, but some species of *Leucophenga* have the interfrontalia more or less hairy. The latter are distinguished, however, by the widely open first posterior cell of the wing, the fourth vein being not or very little bent forward at its apex, and much weaker on its last section than the other veins, I incline to the retention of *Orthostegana* as a good subgenus.

The absence of the pleural vitta is a very good superficial character for the recognition of this species.

Originally described from Bolivia. One female, Higuito, San Mateo, Costa Rica (P. Schild).

STEGANA BRUNNEA Malloch.

Female.—Head testaceous yellow; ocellar spot and apex of third antennal segment black; upper occiput fuscous. Thorax brownish yellow, darker posteriorly; disk of scutellum brown; upper pleural vitta deep black, lower one absent. Abdomen dark brown. Legs yellow, apices of fore femora on anterior side, and a large mark on anterior side of mid femora dark brown, hind femora and mid and hind tibiae faintly or not at all marked with brown. Wings brown, paler posteriorly. Halteres yellow.

Eye much higher than long; cheek about half as high as width of third antennal segment; face with a low sharp carina on upper half in center; antennae extending to mouth. Humeri with one bristle. Fore tarsi slightly compressed. Inner cross-vein a little in front of middle of discal cell.

Length, 2 mm.

Type and two paratypes, Higuito, San Mateo, Costa Rica (P. Schild).

Type.—Female, Cat. No. 26676, U.S.N.M.

STEGANA AFFINIS Malloch.

Male.—Head testaceous yellow, ocellar spot, a transverse line above mouth, and the third antennal segment black. Mesonotum brownish yellow, darker on sides; disk of scutellum brown; upper pleural vitta complete, lower one present only on sternopleura. Abdomen dark brown. Legs yellow, fore femora at apices on anterior side, fore tibiae on most of apical half, mid and hind femora except bases brown, tibiae of mid and hind legs hardly darkened basally. Wings brown, paler posteriorly. Halteres brown.

Eye as high as long; cheek at least half as high as width of third antennal segment; antennae extending to mouth. Thorax and wing as in last species.

Length, 2.5 mm.

Type, Higuito, San Mateo, Costa Rica (P. Schild).

Type.—Male, Cat. No. 26677, U.S.N.M.

STEGANA CONFORMIS Malloch.

Female.—Differs from *affinis* in having the labrum and upper part of face brownish, the mid and hind femora less broadly browned, lower pleural vitta absent, and as stated in the key.

The eye is distinctly higher than long and the inner cross-vein is at middle of discal cell.

Length, 2.5 mm.

Type and paratype, Higuito, San Mateo, Costa Rica (P. Schild).

Type.—Female, Cat. No. 26673, U.S.N.M.

STEGANA FLAVIMANA Malloch.

Male.—Head fuscous, bases of antennae, cheeks and lower half of occiput yellow. Mesonotum and abdomen fuscous brown: pleura pale yellow, with the upper pleural vitta black and complete. Wings brown, paler posteriorly. Halteres yellow.

Frons at anterior margin less than half as wide as its median length; eye one fourth higher than long; cheek linear. Apical scutellar bristles nearly as long as basal pair. Inner cross-vein at middle of discal cell.

Length, 2 mm.

Type, Higuito, San Mateo, Costa Rica (P. Schild).

Type.—Male, Cat. No. 26672, U.S.N.M.

STEGANA FUSCIBASIS Malloch.

Male.—Similar to *flavimana*, differing as stated in the key.

The eye is a little longer and the frons a trifle wider than in *flavimana*.

Length, 2.5 mm.

Type, Higuito, San Mateo, Costa Rica (P. Schild).

Type.—Male, Cat. No. 26671, U.S.N.M.

STEGANA CRISTIMANA, new species.

Male.—Shining yellowish brown, apical half of third antennal segment, a vitta on upper half of pleura, and apical three segments of fore tarsi black; ocellar spot, upper part of sternopleura, and tip of abdomen darkened. Wings browned, more noticeably on anterior half. Halteres yellow.

Eyes higher than long, not oval but almost subquadrate, occupying almost all of side of head; cheek almost linear; front glossy, anteriorly not over one-fourth of head width, at vertex about one-half the head width; proclinate bristle opposite middle of frons; orbits not differentiated; carina on upper half of face low, rounded; antennae extending to mouth-margin. Scutellum broader than long, rounded in outline, apical bristles not half as long as basal pair. Fore tarsi

with segments 1 to 4 compressed, first nearly as high as long, second about twice as high as long, third and fourth each with a long dorsal extension which is blunt at apex, of uniform width and about four times as high as length of segment. Inner cross-vein at middle of discal cell; second vein bent towards costa at its middle, joining costa almost at a right angle.

Length, 2.5 mm.

Type, Alhajuelo, Panama, March 12, 1912 (A. Busck).

In my key to the species of this genus already referred to this species will run to caption 3. From both species therein included it will be readily distinguished by the remarkably compressed fore tarsi as well as their color, and from *tarsalis* by the yellow palpi.

Type.—Cat. No. 26997, U.S.N.M.

STEGANA NIGRIMANA, new species.

Male.—Frons more suffused with brown than in the last species, lower margin of face brown or fuscous, dorsum of thorax fuscous brown, abdomen largely fuscous, fore tarsi black except the base of first segment, apices of fore femora, almost all of mid and hind femora, and the greater part of mid tibiae brown; halteres brown; wings more uniformly brown than in last species.

Structurally similar to last species, but the fore tarsi are less conspicuously compressed, segments 2 to 4 being equally high, and about twice as high as long.

Length, 2 mm.

Type and one male paratype, Alhajuelo, Panama, March 12, 1912 (A. Busck).

This species will run to the same caption as last in my key already referred to but may be distinguished from *tarsalis* by the yellow palpi, and from the other species by the differently colored fore tarsi.

Type.—Cat. No. 26998, U.S.N.M.

LEUCOPHENGA BRAZILENSIS, new species.

Male.—Head rufous, occiput dark brown, palpi infuscated. Thorax brownish yellow, pleura paler. Abdomen marked as in *varia* Walker, but the black spots are more transverse and those on second and third visible tergites are connected along the hind margins; the maculation is obviously 2, 5, 5, 5, 2, though in type only the second tergite has outer spot on each side separated from the next one. Legs pale yellow. Wings hyaline, with a fuscous cloud from apex of subcostal cell to inner cross-vein and extending basally as far as furcation of second and third veins, a similar cloud from before middle of second section of costa to tip of wing and suffusing disk of wing between third vein and costa, and a conspicuous clouding over outer cross-vein.

Each orbit with three strong bristles, the anterior two at middle and almost at same height; palpi slightly broadened. Wing venation as in *varia.*

Length, 3 mm.

Type, Petropolis, Brazil (P. Borgmeier).

Type.—Cat. No. 26700, U.S.N.M.

CLASTOPTEROMYIA FLORIDANA, new species.

Female.—Similar to *inversa* in color and habitus. Differs as follows: Mesonotum with a rather indistinct central vitta and traces of two similar vittae between this and lateral margins; mesonotal setulae in front of dorsocentrals longer, finer, and less numerous than in *inversa;* wings as in that species, the cross-veins more pronouncedly clouded; comparative lengths of penultimate and ultimate sections of fourth vein 9.5:15, in *inversa* about 10:20; outer cross-vein at very little more than its own length from end of fifth vein.

Length, 1.5 mm.

Type, Fort Lauderdale, Fla., February 18, 1919 (A. Wetmore).

Nothing is known of the habits of this species.

Type.—Cat. No. 26699, U.S.N.M.

CLASTOPTEROMYIA TRISETA, new species.

Male.—Similar to *inversa* Walker in color and habitus. General color pale brown, third antennal segment and palpi subfuscous, thorax not vittate, abdomen dark brown, legs stramineous, wings almost uniformly pale brown.

Each orbit with three bristles, the upper reclinate and the proclinate one equally long, the lower reclinate one situated about half as far in front of proclinate one as the latter is in front of the upper reclinate; palpi rather longer than usual. Thorax similar to that of *inversa*, but the prescutellar acrostichals are absent. Last section of fourth vein as compared with preceding section 16: 10; outer cross-vein at less than twice its own length from apex of fifth vein; second section of costa twice as long as third.

Length, 1.5 mm.

Type, Higuito, San Mateo, Costa Rica (P. Schild).

Type.—Male. Cat. No. 26686, U.S.N.M.

DROSOPHILA SCHILDI, new species.

Female.—Similar in general color and habitus to *calliptera* Schiner. Differs in having the ocellar spot and the mark surrounding the vertical bristles on upper extremity of each orbit larger and darker, the scutellum dark brown with gray pruniescent marks on margin and on a small round one in center of disk; the tibiae with a faint brown preapical mark which is absent in *calliptera*, and the wings differently marked. In *calliptera* there are but three fuscous spots between apices of first and second veins exclusive of the dark mark on first, the third one covering apex of second vein, in *schildi*

there are four such spots, the second and third connected along second vein, the first with a spur of a vein in its center which is emitted from second vein, the dark mark over apex of first vein extending more into the cell; in *calliptera* there is a large spot on apex of third vein and a narrow brown mark along wing tip between and beyond apices of veins 3 and 4, but in *schildi* the dark spot is well removed from the apex of third vein and there is no brown marginal mark along tip of wing between the veins; in *schildi* there is also a fuscous spot in the submarginal cell below the first spot in marginal cell which is not present in *calliptera*.

Length, 3 mm.

Type and three paratypes, Higuito, San Mateo, Costa Rica (P. Schild).

Type.—Female, Cat. No. 26685, U.S.N.M.

SCAPTOMYZA NIGRIPALPIS, new species.

Female.—Reddish testaceous, thorax slightly, abdomen distinctly shining. Head clay colored, paler on frontal orbits; ocellar region brown; apices of palpi black or fuscous. Thoracic dorsum with gray pruinescenece and three broad brown vittae, the median one extending to tip of scutellum; pleura with a broad brown vitta along upper margin. Each tergite of abdomen blackish, with an interrupted black facia on anterior half. Legs yellow. Wings hyaline.

Palpi normal, apices with a rather long setulose hair. Humeral angle with one bristle: only two distinct pairs of dorsocentrals present; apical pair of scutellar bristles not over half as long as basal pair. Abdomen slender. Legs normal. Inner cross-vein at about one third from base of discal cell; penultimate section of fourth vein about three fourths as long as ultimate section; last section of fifth vein about one third longer than outer cross-vein.

Length, 1.5 mm.

Type and three paratypes, Alto Itatiaya Serro do Itatiaya, southeast Brazil, 7,150 feet, February 21, 1922 (E. G. Holt).

Type.—Cat. No. 26701, U.S.N.M.

SCAPTOMYZA FUSCINERVIS, new species.

Female.—Differs from the last species in having the thorax more shining posteriorly on dorsum, the dorsal vittae much less noticeable, the median one not evident on scutellum: the scutellum shorter and convex, not flattened on disk, the abdomen almost uniformly glossy dark brown; and the bases of the wing veins distad of the humeral cross-vein and including the costal vein on almost its entire length darker than the remainder of the veins.

Length, 1.5 mm.

Type and two paratypes, same locality as last species.

Type.—Cat. No. 26702, U.S.N.M.

O

SENECELLA CALANOIDES, A RECENTLY DESCRIBED FRESH-WATER COPEPOD

By Chancey Juday

Biologist of the Wisconsin Geological and Natural History Survey

During the summers of 1910 and 1918 limnological studies of the Finger Lakes of New York were made for the United States Bureau of Fisheries. Plankton catches were obtained from the various lakes that were visited, and a recent taxonomic study of the copepods in this material led to the discovery of an interesting calanoid form which represented not only a new species but also a new genus of fresh-water Copepoda. This copepod was found in catches obtained from the lower water of 3 of the 10 lakes that were studied, namely, Seneca, Cayuga, and Owasco. It was briefly characterized in *Science*.[1]

Genus SENECELLA Juday

Senecella Juday, Science (n. s.), vol. 58, 1923, p. 205.

Generic characters of male and female.—The cephalothorax is nearly three times as long as its maximum width, evenly and gradually vaulted anteriorly, without a rostrum or rostral filaments at the anterior end. The head is only indistinctly separated from the first thoracic segment. In the female the first thoracic segment is strongly carinated on its ventral surface. The abdomen is symmetrical, consisting of four segments in the female and five in the male, the fifth segment in the latter being very short. The caudal rami in both sexes are rather short; each ramus bears five terminal setae and a small seta on the upper surface near the middle of the inner edge, ciliated on the inner margin.

The first antennae are longer than the cephalothorax, with 25 segments. The right antenna is exactly like the left in the adult male. Each antenna bears 15 sensory appendages in the adult male, but only 7 in the female. The eighth and ninth segments are more

[1] New Series, vol. 58, 1923, p. 205.

distinctly separated in the male than in the female. The outer rami of the second antennae consist of 7 segments.

The mandible, the maxilla, and the first maxilliped of the adult male are greatly reduced. The terminal part of the second maxilliped consists of five short segments which are reflexed on the second basal segment in both sexes.

The inner ramus (endopodite) of the first pair of swimming legs consists of one segment, that of the second pair of two segments, and those of the third and fourth pairs of three segments. The outer ramus (exopodite) of the first to fourth pairs of swimming legs is three-segmented. The fifth pair of legs is absent in the female, but large and greatly modified in the adult male.

SENECELLA CALANOIDES Juday

Senecella calanoides JUDAY, Science (n. s.), vol. 58, 1923, p. 205.

One female has been selected as the type of the species and has been given Cat. No. 57707, U.S.N.M. There are in addition 10 paratypes, females, Cat. No. 57708, U.S.N.M., and 11 male specimens. Cat. No. 57709. U.S.N.M.

Characters of female.—In a dorsal view (pl. 1, fig. 1) the body is evenly rounded in front, but it is rather sharply truncated posteriorly; in a side view (pl. 1, fig. 2) the ventral margin is nearly straight, while the dorsal margin is evenly rounded both anteriorly and posteriorly. The last segment of the thorax bears only moderate sized lateral expansions.

The abdomen is made up of four segments. The first or genital segment is nearly as long as the other three combined and is somewhat dilated on the ventral surface, with the genital opening approximately in the middle of the segment. Caudal rami less than twice as long as broad. More than 200 females were examined for ovisacs, but none was found; it seems probable therefore that the eggs are not carried during the period of incubation in this form.

The first antenna (pl. 1, fig. 3) is made up of 25 segments, the eighth and ninth being somewhat coalesced. When reflexed, the antenna reaches the end of the first segment of the abdomen. Each antenna bears seven sensory appendages, one each on the second, fifth, ninth, twelfth, fourteenth, nineteenth, and twenty-fifth segments.

The second antenna (pl. 1, fig. 4) is medium sized; the inner ramus is somewhat broader than the outer. The outer ramus is made up of seven segments, of which the second and the seventh are the longest; the inner ramus is two-segmented.

The mandible (pl. 1, fig. 5) bears only a moderately expanded masticatory part; the cutting edge is armed with several teeth.

The maxilla is foliaceous and bears a number of setae of various lengths. (pl. 1, fig. 6.)

The first maxilliped (pl. 2, fig. 7) is well developed and is armed with a number of plumose setae. The second maxilliped (pl. 2, fig. 8) is elongated and the terminal part is reflexed on the second basal segment.

The inner ramus of the first pair of swimming legs (pl. 2, fig. 9) has only one segment; it bears three setae on the inner margin and two at the apex. There is a ciliated prominence on the outer margin of this ramus. The penultimate segment of the outer ramus is armed with a spine at its outer distal angle.

The inner ramus of the second pair of swimming legs (pl. 2, fig. 10) has two segments; the first segment bears a plumose seta on its inner margin and the second has two setae on the inner margin, two at the apex, and one on the outer margin. The first and second segments of the outer ramus possess a spine of moderate size and one of minute size at the outer distal angle. The third segment has one spine on its outer margin and three terminal spines; the inner terminal spine is large and is armed with teeth on its outer margin.

The first basal segment of the third pair of swimming legs (pl. 2, fig. 11) bears a plumose seta on its inner margin as does that of the second pair of legs. The first basal segment of the fourth pair of legs (pl. 2, fig. 12) has a spine on the inner margin which is shaped somewhat like a spur: this pair of spines probably has some sexual function since one lies on either side of the genital opening when these legs are reflexed against the body.

The inner ramus of the third and fourth pairs of swimming legs is three-segmented; the armature is the same as that of the inner ramus of the second pair of legs with an extra seta on the additional segment. The outer ramus of the third and fourth pairs of legs is like that of the second pair.

The fifth pair of legs is absent in the female.

Length of female, 2.65 to 2.85 millimeters.

Characters of male.—The male is somewhat smaller and more slender than the female. (pl. 2, figs. 13 and 14.) The abdomen is made up of five segments; the first four are about equal in length, but the fifth is small. The genital opening is situated on the left side of the first abdominal segment. The caudal rami are small, only a little longer than broad.

The first antenna is made up of 25 segments (pl. 3. fig. 15); the right antenna is not modified in any way, but is exactly like the left. Each antenna bears 15 sensory appendages.

The second antenna is like that of the female.

The mandible, the maxilla, and the first maxilliped are much reduced in the adult male. (pl. 3, figs. 16–18.) In immature males which are only 0.1 to 0.2 millimeter shorter than the adults, these mouth parts are like those of the female; this indicates that the reduction takes place during the final moult in transforming to an adult. Figure 16 shows that the masticatory part of the mandible is very weak and has only a small cutting edge.

The second pair of maxillipeds and the first three pairs of swimming legs of the male are like those of the female. The fourth pair of legs of the male differs from that of the female in that the first basal segment does not possess a spine on the inner margin, but it has instead a small, cuplike depression about two-thirds of the way toward the outer end.

The fifth pair of legs of the male (pl. 3, fig. 20) is unusually large, asymmetrical, and greatly modified for the transfer of the spermatophores. The proximal third of the first basal segment is fused. The second basal segment of the right leg is large, quadrangular, and about as long as broad. The inner ramus of the right leg is elongated, reaching beyond the second segment of the outer ramus, with the outer margin and the distal third hyaline. The first segment of the outer ramus of the right leg is elongated, subtriangular in outline, with a small spine on its outer margin. A narrow hyaline lamella arises at the inner distal angle of this segment and extends outward along the second segment and the base of the terminal hook. The second segment of the outer ramus is small and bears a small, inward-projecting spine at its outer distal angle; it also bears a long terminal hook which is recurved at the outer end.

The second basal segment of the left leg is oblong, nearly twice as long as broad. The inner ramus of this leg consists of a broad, somewhat triangular basal portion, with a digitiform process at the outer distal angle; the outer margin and the fingerlike process are hyaline. The second segment of the outer ramus of the left leg is larger than the first and possesses a protuberance at the inner proximal angle; the second segment terminates in a conical process, with a small spine at the base of this process.

Length of adult male, 2.45 to 2.55 millimeters.

The fifth pair of legs of an immature male 2.35 millimeters long is shown in plate 3, figure 19. These appendages are still comparatively simple when this stage is reached, the chief modification taking place between this and the adult stage. The first antenna of an immature male of this size is like that of the female, with seven sensory appendages and with the eighth and ninth segments

somewhat coalesced. Likewise the mandible, the maxilla, and the first maxilliped are like those of the female.

The absence of the fifth pair of swimming legs in the female, the reduction of three oral appendages in the adult male, and the fact that the right member of the first pair of antennae is like the left in the adult male serve to distinguish *Senecella calanoides* from the other fresh-water Calanoida that are known at the present time. These characters give it a much closer relationship to some of the marine calanoids than to the other fresh-water members of this group.

Distribution.—*Senecella calanoides* was obtained from the lower water of Seneca Lake and of Cayuga Lake, N. Y., in September, 1908, in August, 1910, and in July, 1918, and from Owasco Lake in August, 1910. Through the kindness of N. K. Bigelow of the Royal Ontario Museum of Zoology and of Dr. W. A. Clemens of the University of Toronto, plankton material containing *Senecella* has been obtained from two Canadian lakes, namely, Lake Timagami and Lake Nipigon.

In a personal communication dated May 8, 1924, Dr. C. Dwight Marsh states that he collected immature specimens of an unknown copepod in Pine Lake, Michigan, in 1894, and in Lake Superior near Duluth, Minn., in 1898, and he now finds that these juvenile specimens are identical with those of *Senecella calanoides* from Seneca Lake.

In a recent note [2] attention was called to the fact that *Senecella* was not associated with *Limnocalanus* in the New York lakes, but the material from Lake Nipigon contains both forms, the latter being much more abundant than the former. In the New York lakes *Senecella* was not present in the upper 15 meters of water in the summer, but in Lake Nipigon it has been taken where the water was less than 2 meters deep.

EXPLANATION OF PLATES

PLATE 1

FIG. 1. Dorsal view of female, × 28.
2. Side view of female, × 28.
3. First antenna of female, × 43.
4. Second antenna of female, × 75.
5. Mandible of female, × 114.
6. Maxilla of female, × 114.

[2] Science (new ser.), vol. 58, 1923, p. 205.

Plate 2

FIG. 7. First maxilliped of female, × 114.
8. Second maxilliped of female, × 114.
9. Left member of first pair of swimming legs of female, × 75.
10. Left member of second pair of swimming legs of female, × 75.
11. Left member of third pair of swimming legs of female, × 75.
12. Left member of fourth pair of swimming legs of female, × 75.
13. Dorsal view of adult male, × 28.
14. Side view of adult male, × 28.

Plate 3

FIG. 15. First antenna of adult male, × 43.
16. Mandible of adult male, × 114.
17. Maxilla of adult male, × 114.
18. First maxilliped of adult male, × 114.
19. Fifth pair of legs of immature male, × 75.
20. Fifth pair of legs of adult male, × 75.

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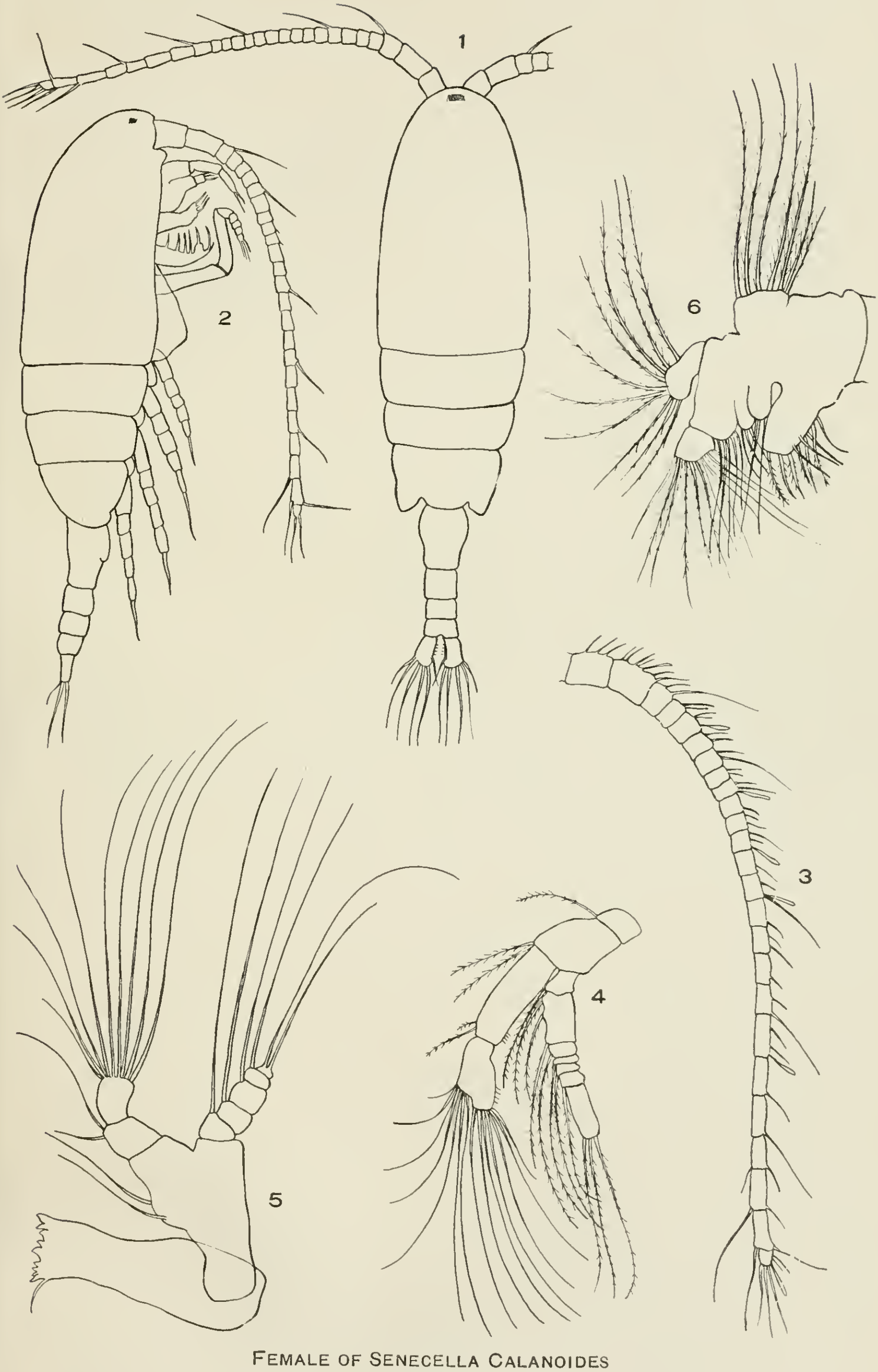
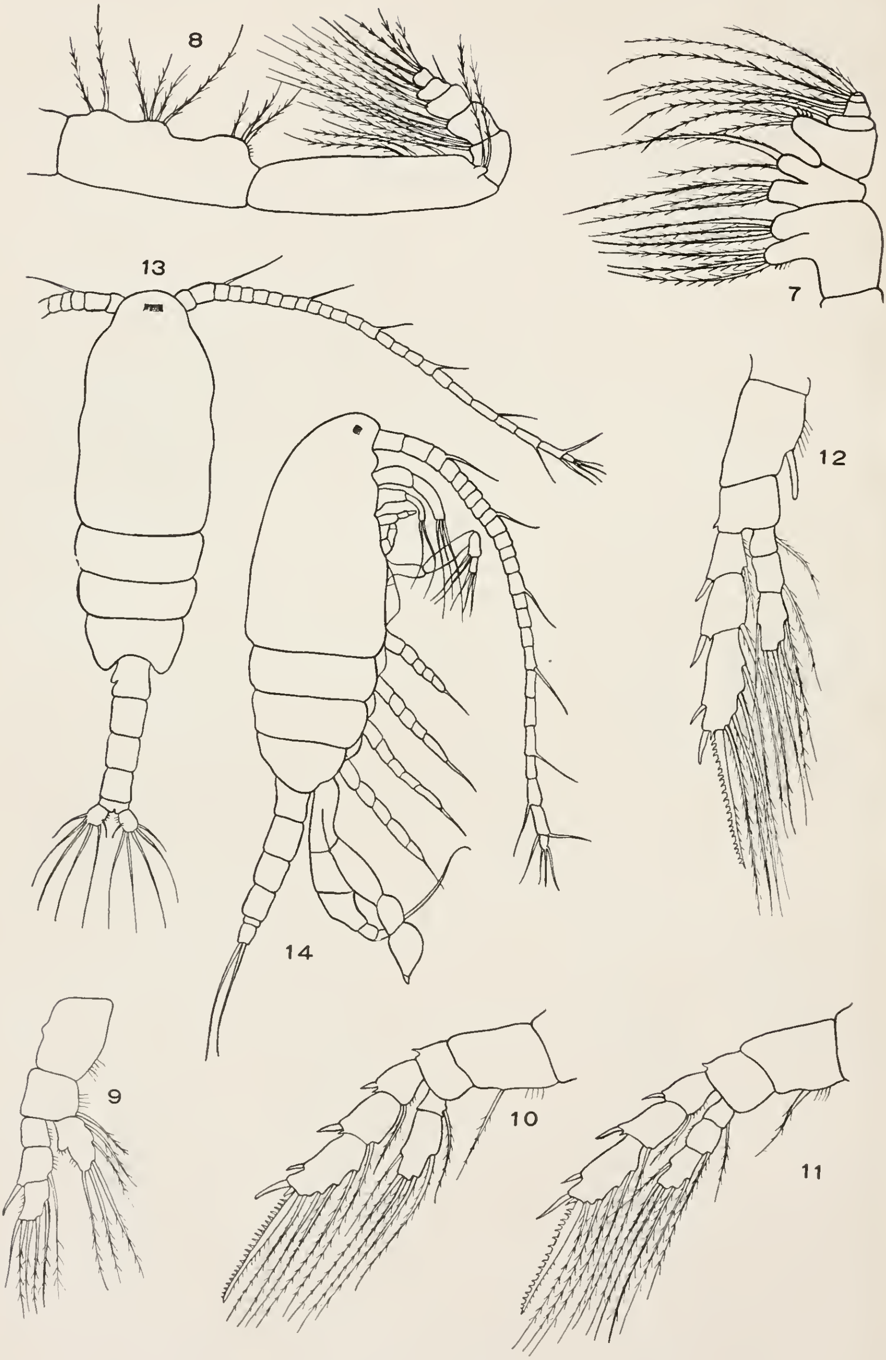


FEMALE OF SENECELLA CALANOIDES

FOR EXPLANATION OF PLATE SEE PAGE 6



MALE AND FEMALE OF SENECELLA CALANOIDES

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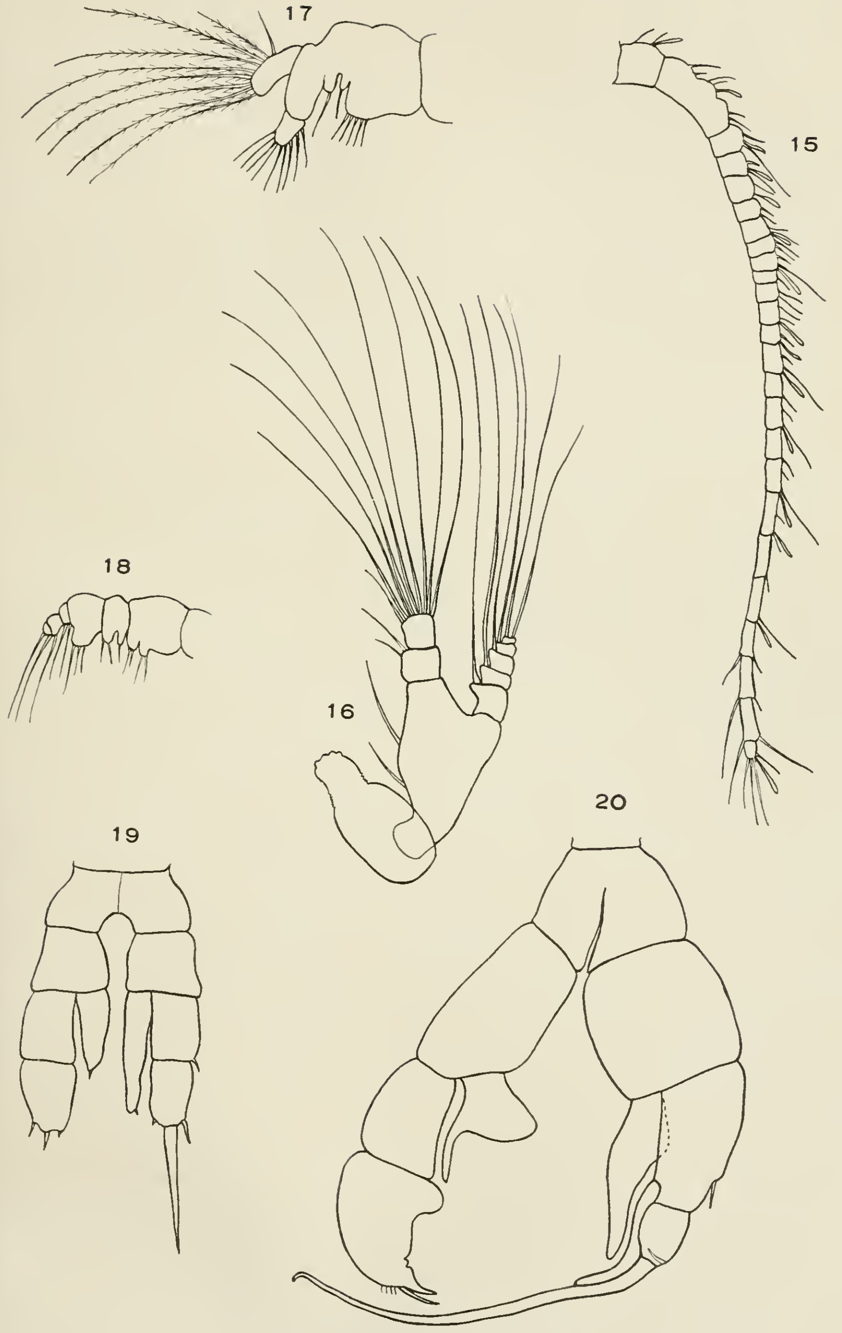

MALE OF SENECELLA CALANOIDES

FOR EXPLANATION OF PLATE SEE PAGE 6

A CONTRIBUTION TOWARD THE CLASSIFICATION OF THE WEEVIL LARVAE OF THE SUBFAMILY CALENDRINAE, OCCURRING IN NORTH AMERICA.

By Richard T. Cotton,

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INTRODUCTION.

Until quite recently the larvae of the family Curculionidae have received little attention from taxonomic workers in entomology. Numerous descriptions of economic forms have appeared from time to time but for the most part they are so vague and fragmentary as to be useless for purposes of identification. In recent years Hopkins, Böving, Grandi, Trägårdh, Donisthorpe, Pierce, and others have published detailed descriptions of certain economic forms, which will serve as a basis for future study of this most interesting group of larvae.

Several years ago the writer became interested in the study of the larvae of the family Curculionidae, particularly those belonging to the subfamily Calendrinae, and as opportunity offered, studies were made of the different forms of this group. The writer is very much indebted to Dr. A. G. Böving for his constant help and advice in the preparation of this paper. Through the kindness of Dr. L. O. Howard the collection of Calendrine larvae belonging to the United States National Museum was made available for study and made possible the completion of the work. The writer is also indebted to A. F. Satterthwait for the loan of his collection of larvae of the genus *Calendra*.

SUBFAMILY CALENDRINAE IN NORTH AMERICA.

The subfamily Calendrinae is represented in North America by eleven genera and about ninety species. Of the ninety known species more than two-thirds belong to the genus *Calendra* (*Sphenophorus*).

The following classification deals only with generic characters and is based on a study of the larvae of all the genera of this subfamily

found in North America with the exception of *Trichischius*, the larva of which is unknown, and *Eucactophagus*, of which the species listed for North America are introduced forms not known to be established in this country.

SUBFAMILY CHARACTERS.

The following characters which are common to all larvae of this subfamily will serve to distinguish them from other Curculionid larvae:

1. Curculionid larvae with head free, subglobular. Eighth and ninth abdominal segments forming a sort of pygidial plate, eighth with tergum declivous and without distinct tergal areas, ninth rather small, somewhat flattened dorsally, either broadly rounded posteriorly or terminating with two fleshy latero-caudal projections, segment usually with four long terminal setae on each side. Tenth abdominal segment small and ventral.
2. Abdominal segments usually with three plicae on dorsal side but occasionally with two or four. Abdominal hypopleura subdivided into at least two and usually three or more superposed lobes.
3. Ocellus one.
4. Antennae fleshy, two-jointed, basal joint with several small papillae.
5. Mandibles stout, triangular, with simple or slightly bifid apex; two dorsal setae.
6. Maxillary palp two-jointed.
7. Hypopharynx composed of a fleshy median area and two setose lateral lobes.
8. Spiracles bifore except in *Rhynchophorus* where bilabiate; all spiracles lateral with air tubes pointing dorsad except on eighth abdominal segment where they are placed dorsally and with air tubes pointing caudad. Spiracular opening oval.

DETAILED DESCRIPTION.

The full-grown larvae of the subfamily Calendrinae do not differ radically in general appearance but vary in length from 2.5 mm. in the genus *Sitophilus* to about 35 mm. in the genus *Rhynchophorus*. They are white, legless, fleshy grubs, very thick-bodied. Body integument usually soft and smooth, sometimes with numerous chitinized setae-carrying areas as in *Rhynchophorus*, and in some species of *Cactophagus* with rows of small spines.

Ten abdominal segments, ninth flattened and forming with the eighth a sort of pygidial plate, tenth reduced and ventral.

Head from very pale yellowish-brown to dark reddish-brown in color; longer than broad and somewhat wedge-shaped, the sides

broadly rounded from middle to apex, which is somewhat angular; the sides nearly straight from middle to posterior angles.

Epicranial and frontal sutures distinct; in many genera a longitudinal suture, the adfrontal suture, branches from each of the frontal sutures and usually continues to the posterior end of the head limiting the so-called adfrontal region. In *Cosmopolites* an additional suture runs parallel to and a short distance from the adfrontal suture.

Frons subtriangular, sometimes with endocarina indicated by a short, dark, median line on the surface. Frons provided with five pairs of setae.

Clypeus broadly transverse and bearing at suture separating clypeus and epistoma two fine setae on each side.

Labrum subtriangular, broader than long. On the dorsal surface labrum bears six large setae, usually simple but in *Cosmopolites* and *Metamasius* with some of them branched; on the margin it has 10 or more thickened setae that are simple in some species and branched in others or both simple and branched.

Each epicranial half bears nine large setae and usually one or more minute setae near occiput.

Eye represented by a single ocellus.

Antennae fleshy, two-jointed, located at the lateral angle of frons; first joint broad and short and supplied with several small papillae, second slender and short.

Mandible stout, triangular, at tip with single blunt tooth or slightly bifid, two dorsal setae, no molar part.

Maxilla with cardo distinct and simple. Maxillary mala entire, tip obtuse, ventral surface smooth and lightly chitinized, dorsal surface with a longitudinal row of simple or branched setae and in *Rhynchophorus* proximally with a group of setae. Tip of mala usually with a group of three strong setae. Maxillary palp extending slightly beyond mala, two-jointed, borne by a large membraneous palpifer. Proximal joint thick, cylindrical and bearing a single seta on apical membrane, distal joint finger-like, bearing several small terminal papillae. There are three other setae on maxilla, two near base of palpifer and one about midway between palpus and end of cardo. A very minute seta with sensory spot is present near stipes labii but usually concealed by folded skin.

Mentum, submentum, and maxillary articulating area fused into a fleshy region. Three pairs of setae are present. Eulabium posteriorly enforced by a median triangularly-bent chitinization. Between the palpi a small slightly bilobed ligula. Labial palp short, conical, two-jointed, distal joint with several small terminal papillae. Eulabium bears two setae on ventral surface; ligula bears four setae and two sensory spots. These setae are simple in some

and branched in others. In some genera the buccal side of ligula is smooth, partly provided with, or in others entirely covered with a dense mat of hairs.

The main part of the floor of the buccal cavity is composed of the hypopharynx, a fleshy median area, with two setose lateral lobes by many authors interpreted as the maxillulae or paragnathae. Each side of this hypopharyngeal complex is strengthened by a chitinized arm of mentum.

Epipharynx carries a pair of epipharyngeal rods. Between these rods there are four or more small, thickened setae, the number and arrangement differing in the different genera. These setae are simple in most genera but branched in *Scyphophorus*. Epipharynx is often more or less densely setose.

Prothorax dorsally not divided, but the two areas praescutum and scuto-scutellum may be roughly indicated by rows of setae.

The mesothoracic and metathoracic segments are divided into the spindle-shaped praescutum, the scuto-scutellum, and the alar area. Praescutum has one pair of setae and scuto-scutellum four pairs of setae.

The sternum of the thorax consists of eusternum and two coxal or parasternal lobes more or less connected medianly behind the eusternum. The eusternum of each thoracic segment bears a pair of hairs.

The abdominal segments are divided dorsally into from two to four transverse areas. In *Rhynchophorus* and *Cosmopolites* an additional intersegmental fold is present in front of praescutum. Below these transverse areas and adjacent to epipleurum is the alar area. Epipleurum itself dorsally limited by a somewhat indistinct dorso-lateral suture and ventrally by a well-defined ventrolateral suture; it is large and not subdivided. Below the ventrolateral suture is hypopleurum. This is subdivided into at least two and usually three or more superposed lobes. The ventral areas are the coxal or parasternal lobes, eusternum, and sternellum. The anus is transverse. Abdominal segments provided with setae as follows: On each side of all typical segments praescutum bears one seta, scutellum from three to five setae, alar area one or two setae, and the epipleural lobe a pair of setae. One of the lobes of hypopleurum bears one or two setae, the coxal lobe one seta, and eusternum two pairs of setae.

Eighth abdominal segment smaller than the typical segments, tergum declivous and without distinct tergal areas. Ninth segment rather small, somewhat flattened dorsally, either broadly rounded posteriorly or terminating with two fleshy latero-caudal projections; segment usually with four long terminal setae on each side. Tenth abdominal segment ventral and small.

Spiracles lateral except on the eighth abdominal segment, where they are placed dorsally. Spiracular opening oval.

Both thoracic and abdominal spiracles located anteriorly and in a separate corner area. The area containing the mesothoracic spiracles, however, is epipleural, while the areas with the abdominal spiracles are derived from the alar area. With the exception of *Rhynchophorus*, where the spiracles are bilabiate, they belong in all genera to the bifore type.

Only one pair of thoracic spiracles are present, the mesothoracic pair; no vestige of a metathoracic spiracle found. All spiracles of same size except the mesothoracic and eighth abdominal; the mesothoracic being about twice as large and the eighth abdominal spiracle considerably larger than the average abdominal spiracle.

The air tubes of the bifore spiracles distinct but varying in size according to the genera; those of mesothorax and abdominal segments 1–7 point dorsad but those of the eighth abdominal segment are directed caudad.

The closing apparatus of the spiracle is similar to that found by Böving in the larvae of the Donaciinae, a detailed description of which appears in his Natural History of the Larvae of Donaciinae.[1]

As shown in plate 7, figure 4, *b* and *c*, the apparatus consists of a constriction of the walls at the beginning of the trachea, formed by a chitinized, wedge-shaped ridge or fold that projects into the lumen of the trachea, and an opposing soft fold that, by the action of a muscle between two hollow arms at the fold, may be forced against the chitinized ridge, thus effectually closing the entrance to the trachea.

KEY TO GENERA.[2]

1. Mala with simple setae or with not more than one branched seta -------- 2
   Mala with branched setae -------- 4
2. Mala dorsally with longitudinal row of eight setae one of which is branched. Distal end of palpifer dorsally with a tuft of hair ---- Cactophagus, p. 6.
   Mala dorsally with longitudinal row of six or seven setae none of which are branched. Distal end of palpifer naked -------- 3
3. Mala with seven dorsal setae. Body elongate, more than 5 mm. in length -------- Rhodobaenus, p. 6.
   Mala with six dorsal setae. Body almost globular, not more than 3.5 mm. in length -------- Sitophilus, p. 6.
4. Dorsal (or buccal) side of ligula setose -------- 5
   Dorsal (or buccal) side of ligula not setose -------- 7

[1] Internationale Revue der Gesamten Hydrobiologie und Hydrographie. 1910. Pp. 50–51, 60–62.

[2] Leng's catalogue has been followed in the use of generic names with the following exceptions: *Calendra* of Leng's catalogue is replaced by *Sitophilus*, and *Sphenophorus* of Leng's catalogue by *Calendra*.

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5. Dorsal side of ligula not densely setose. Eulabium with posterior setae branched. Marginal setae of epipharynx all branched. Intersegmental area present in front of praescutum ____ **Cosmopolites**, p. 7.
   Dorsal side of ligula densely setose. Eulabium with simple setae. Marginal setae of epipharynx not all branched. No intersegmental fold in front of praescutum ____ 6
6. Mala distally truncate ____ **Metamasius**, p. 7.
   Mala distally rounded ____ **Calendra**, p. 7.
7. Mala distally truncate, proximally on dorsal side thick set with setae. Large forms about 35 mm. in length ____ **Rhynchophorus**, p. 8.
   Mala distally rounded. Proximally on dorsal side with none or a few setae ____
8. Dorsal (or buccal) side of mala with eight branched setae. Eulabium with simple setae. Marginal setae of epipharynx mostly simple, only a few branched ____ **Scyphophorus**, p. 8.
   Dorsal (or buccal) side of mala with more than eight branched setae. Eulabium with branched setae. Most of marginal setae of epipharynx branched or tuft-like ____ **Yuccaborus**, p. 8.

Genus CACTOPHAGUS LeConte.

Plate 1, figs. 1–7; plate 10, fig. 3.

The larvae of this genus breed in Cactus plants and attain a length of about 30 mm. Labrum with twelve simple, thickened, marginal setae. Epipharynx somewhat setose and with two pairs of small thickened setae between the epipharyngeal rods. Maxillary mala oval at tip, with a row of seven simple and one branched setae on dorsal surface and with three simple setae at tip. Ligula not setose. Hypopharynx fleshy and laterally densely setose. Body with rows of small spines. Abdominal terga above divided into three distinct areas. Abdominal hypopleurum four-lobed.

Genus RHODOBAENUS LeConte.

Plate 2, figs. 1–7; plate 10, fig. 2.

The larvae of this genus inhabit the stems of various weeds of the Compositae. They are somewhat elongate and may attain a length of about 16 mm. Labrum with twelve simple, thickened, marginal setae. Epipharynx with two pairs of small thickened setae between the epipharyngeal rods. Maxillary mala oval at tip, dorsal surface with a longitudinal row of seven simple, stout setae, tip with three simple setae. Ligula not setose. Hypopharynx fleshy and laterally densely setose. Abdominal terga above divided into four distinct areas. Abdominal hypopleurum two or three lobed.

Genus SITOPHILUS Schönherr.

Plate 3, figs. 1–7; plate 10, fig. 1.

The larvae of this genus are seed inhabiting. The three species found in North America are all small, none exceeding 3.5 mm. in

length. Labrum with ten simple thickened marginal setae. Epipharynx with from eight to fourteen small setae between the epipharyngeal rods, the number of these setae differing in the three species. Maxillary mala oval at tip, with a longitudinal row of six simple, stout setae on dorsal surface and with four simple setae at tip, two of the latter being smaller than the others. Ligula not setose. Hypopharynx fleshy and laterally lightly setose. Abdominal terga above divided into two or three distinct areas. Abdominal hypopleurum three-lobed.

Genus COSMOPOLITES Chevrolat.

Plate 4, figs. 1–7; plate 10, fig. 4.

The larvae of the only species of this genus found in North America breeds in the roots of the banana. The larvae attain a length of at least 13 mm. Labrum with twelve marginal thickened setae all of which are branched. Epipharynx setose with two pairs of thickened setae between the epipharyngeal rods. Maxillary mala oval at tip, with a row of nine branched setae on dorsal surface and with one branched and two simple setae at tip. Ligula with two somewhat triangular setose areas on dorsal surface. Hypopharynx fleshy, laterally densely setose. Abdominal terga above divided into four distinct areas and an additional intersegmental fold. Abdominal hypopleurum four-lobed.

Genus METAMASIUS Horn.

Plate 5, fig. 1–7; plate 10, fig. 6.

The larvae of the species found in North America breed in the roots of sugar cane. They attain a length of about 15 mm. Labrum with twelve thickened marginal setae, some of which are branched and others simple. Epipharynx somewhat setose, and with two pairs of small thickened setae between the epipharyngeal rods. Maxillary mala truncate at tip, with a row of eight many branched setae on dorsal surface, and with one branched and two simple setae at tip. Ligula densely setose on dorsal surface. Hypopharynx fleshy, laterally densely setose, chitinized mental arms very prominent. Abdominal terga above divided into four distinct areas. Abdominal hypopleurum three or four lobed.

Genus CALENDRA Clairville.

Plate 6, figs. 1–7; plate 10, fig. 8.

The larvae of this genus breed in the roots of many grasses and grass-like plants. This genus contains many species, some of them attaining a length of about 15 mm. Labrum with twelve marginal,

thickened setae that are simple in some species and branched in others. Epipharynx somewhat setose and with two pairs of small thickened setae between the epipharyngeal rods. Maxillary mala oval at tip, with a row of eight branched setae on dorsal surface, the basal two being bifurcate at tip, the rest many-branched, tip of mala with two simple and one branched setae. Ligula dorsally setose. Hypopharynx fleshy, laterally densely setose and with a tuft of hairs at posterior limit. Abdominal terga above divided into three distinct areas. Abdominal hypopleurum four-lobed.

Genus RHYNCHOPHORUS Herbst.

Plate 7, figs. 1–7; plate 10, fig. 9.

The larvae of this genus breed in the trunks of palm trees. They are the largest of the Calendrid larvae that occur in North America and may attain a length of 35 mm. or more. Labrum with about twenty simple, thickened marginal setae. Epipharynx setose and with two pairs of small thickened setae between the epipharyngeal rods. Maxillary mala subquadrate at tip, with a row of simple and branched setae and a basal group of numerous branched setae on dorsal surface, and with three simple setae at tip. Ligula not setose. Hypopharynx fleshy and laterally densely setose. Body provided with numerous small chitinous seta-carrying areas. Abdominal terga divided above into three distinct areas and with additional intersegmental fold. Abdominal hypopleurum four-lobed.

Genus SCYPHOPHORUS Schönherr.

Plate 8, figs. 1–7; plate 10, fig. 7.

The larvae of this genus breed in plants of the Yucca family and related families. They may attain a length of at least 18 mm. Labrum with twelve thickened, marginal setae of which some are simple and others branched. Epipharynx setose and with two pairs of branched thickened setae between the epipharyngeal rods. Maxillary mala oval at tip, with a row of eight branched setae on dorsal surface and with one branched and two simple setae at tip. Ligula not setose. Hypopharynx fleshy, laterally densely setose. Abdominal terga above divided into three distinct areas. Abdominal hypopleurum five-lobed.

Genus YUCCABORUS LeConte.

Plate 9, figs. 1–7; plate 10, fig. 5.

The larvae of this genus breed in the plants of the Yucca family. They may attain a length of at least 15 mm. Labrum with about eighteen marginal setae nearly all of which are very much branched.

Epipharynx setose and with three pairs of small thickened setae between the epipharyngeal rods. Maxillary mala oval at tip, with a row of about twelve many-branched setae on dorsal surface and with one branched and two simple setae at tip. Ligula not setose. The usual setae found on ligula are all branched. Hypopharynx fleshy, laterally setose. Abdominal terga above divided into three distinct areas. Abdominal hypopleurum four-lobed.

EXPLANATION OF PLATES.

a	atrium	*hp*	hypopharynx
al	alar area	*hyp*	hypopleurum
cm	muscle	*l*	labrum
cox	coxal lobe	*li*	ligula
cr	chitinous ridge	*m*	mala
ep	epipleurum	*pres*	praescutum
er	epipharyngeal rod	*sc*	scutum
eu	eusternum	*scut*	scutellum
f	frons	*sf*	soft fold
ha	hollow arm	*t*	trachea

Plate 1.

Cactophagus validus (LeConte).

Fig. 1. Labrum.
2. Head, dorsal view.
3. Epipharynx.
4. Thoracic spiracle.
5. Full grown larva, lateral view.
6. Mouth parts. ventral view.
7. Mouth parts, dorsal view.

Plate 2.

Rhodobaenus tredecimpunctatus (Illiger).

Fig. 1. Labrum.
2. Epipharynx.
3. Thoracic spiracle.
4. Head, dorsal view.
5. Full grown larva, lateral view.
6. Mouth parts, ventral view.
7. Mouth parts, dorsal view.

Plate 3.

Sitophilus granarius (Linnaeus).

Fig. 1. Labrum.
2. Head, dorsal view.
3. Epipharynx.
4. Thoracic spiracle.
5. Full grown larva, lateral view.
6. Mouth parts, ventral view.
7. Mouth parts, dorsal view.

PLATE 4.

Cosmopolites sordidus (Germar).

FIG. 1. Labrum.
2. Head, dorsal view.
3. Epipharynx.
4. Thoracic spiracle.
5. Full grown larva, lateral view.
6. Mouth parts, ventral view.
7. Mouth parts, dorsal view.

PLATE 5.

Metamasius sericeus (Latreille).

FIG. 1. Labrum.
2. Head, dorsal view.
3. Epipharynx.
4. Thoracic spiracle.
5. Full-grown larva, lateral view.
6. Mouth parts, ventral view.
7. Mouth parts, dorsal view.

PLATE 6.

Calendra callosa (Olivier).

FIG. 1. Labrum.
2. Head, dorsal view.
3. Epipharynx.
4. Thoracic spiracle.
5. Full-grown larva, lateral view.
6. Mouth parts, ventral view.
7. Mouth parts, dorsal view.

PLATE 7.

Rhynchophorus cruentatus (Fabricius).

FIG. 1. Labrum.
2. Head, dorsal view.
3. Epipharynx.
4. Thoracic spiracle.
a. Opening.
b. Longitudinal section of spiracle and trachea showing closing apparatus.
c. Cross section showing closing apparatus of spiracle.
5. Full-grown larva, lateral view.
6. Mouth parts, ventral view.
7. Mouth parts, dorsal view.

PLATE 8.

Scyphophorus acupunctatus (Gyllenhal).

FIG. 1. Labrum.
2. Head, dorsal view.
3. Epipharynx.
4. Thoracic spiracle.
5. Full-grown larva, lateral view.
6. Mouth parts, ventral view.
7. Mouth parts, dorsal view.

PLATE 9.

Yuccaborus lentiginosus (Casey).

FIG. 1. Labrum.
2. Head, dorsal view.
3. Epipharynx.
4. Thoracic spiracle.
5. Full-grown larva, lateral view.
6. Mouth parts; ventral view.
7. Mouth parts, dorsal view.

PLATE 10.

FIG. 1. *Sitophilus*, buccal side of mala.
2. *Rhodobaenus*, buccal side of mala.
3. *Cactophagus*, buccal side of mala.
4. *Cosmopolites*, buccal side of mala.
5. *Yuccaborus*, buccal side of mala.
6. *Metamasius*, buccal side of mala.
7. *Scyphophorus*, buccal side of mala.
8. *Calendra*, buccal side of mala.
9. *Rhynchophorus*, buccal side of mala.

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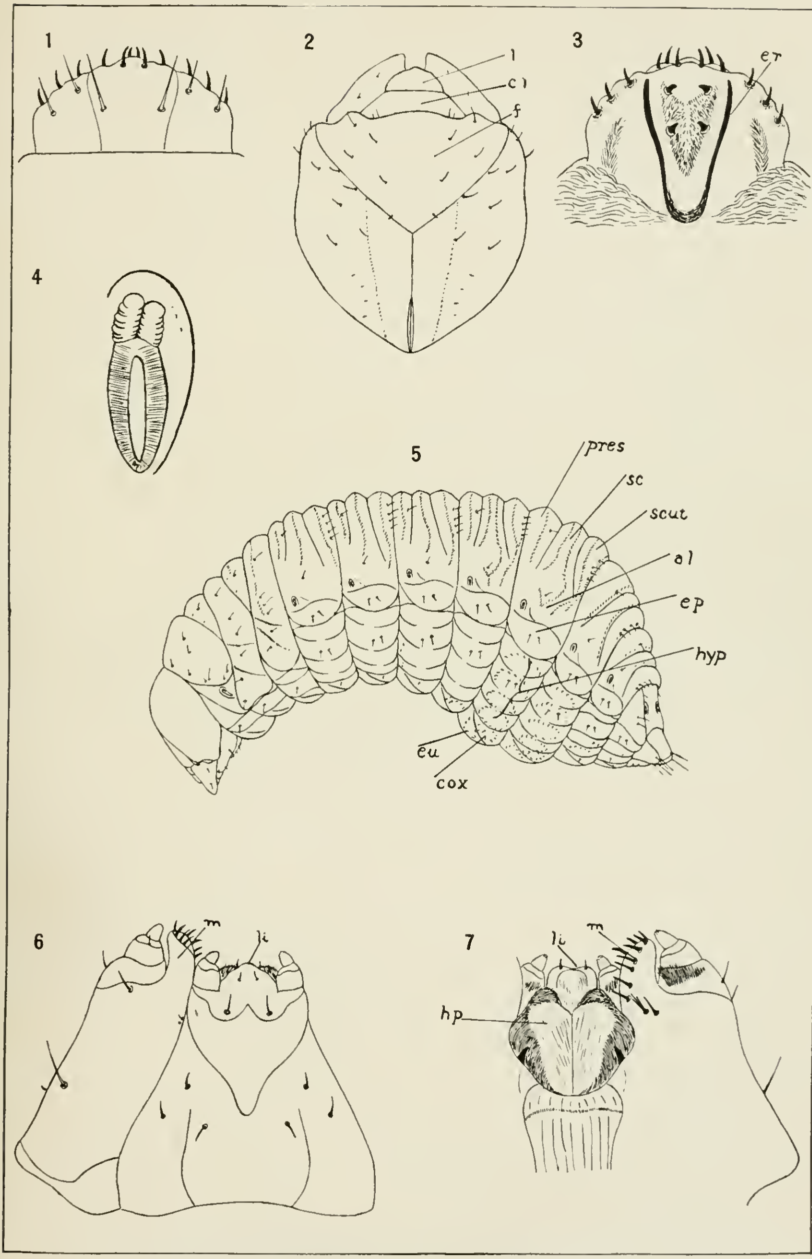
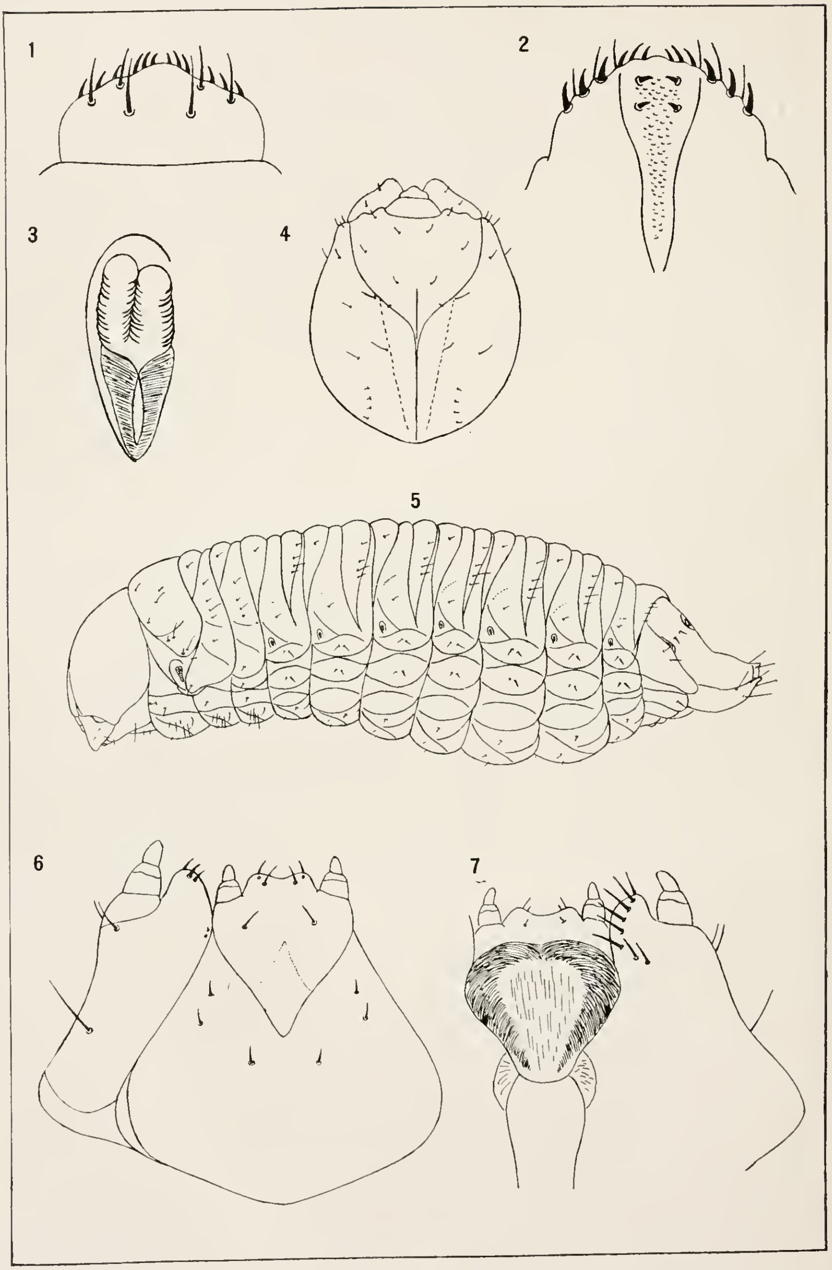


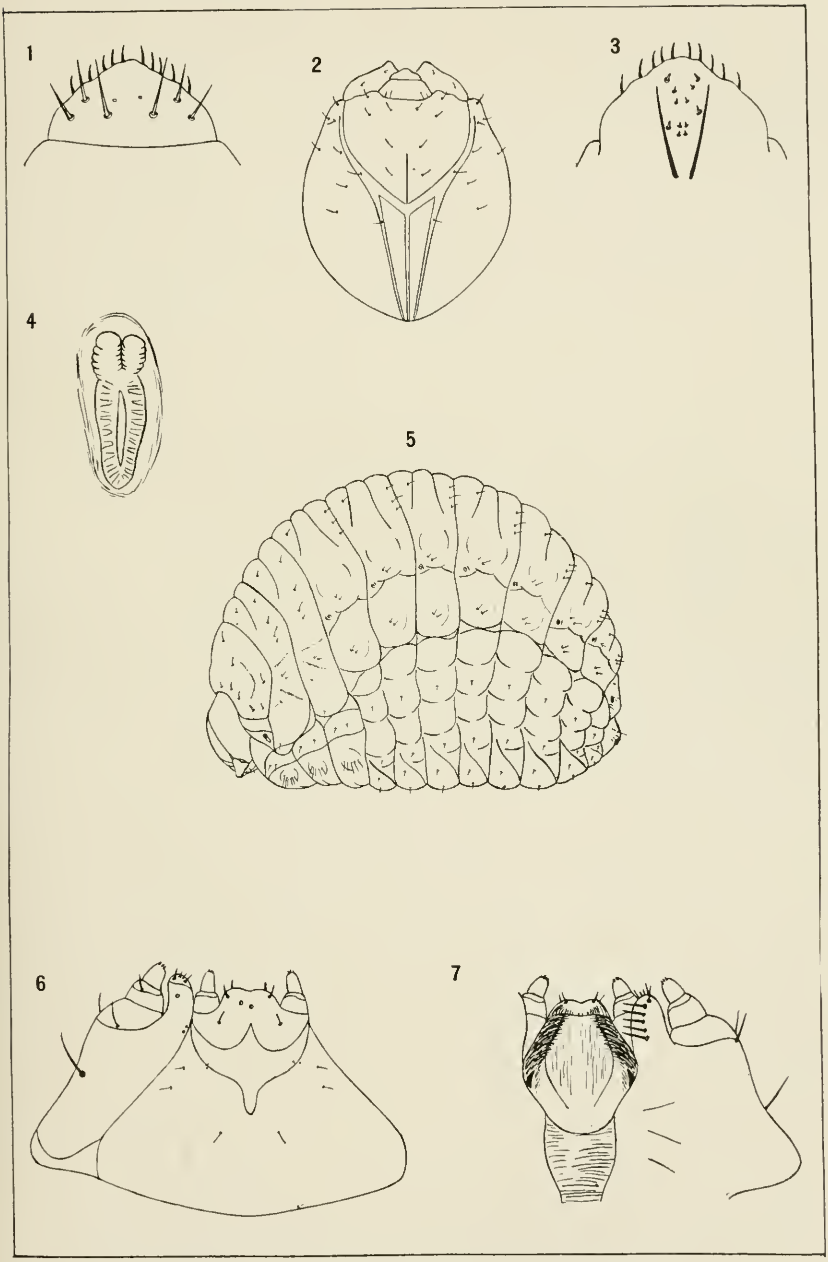
DETAILS OF CACTOPHAGUS VALIDUS (LECONTE)

FOR EXPLANATION OF PLATE SEE PAGE 9



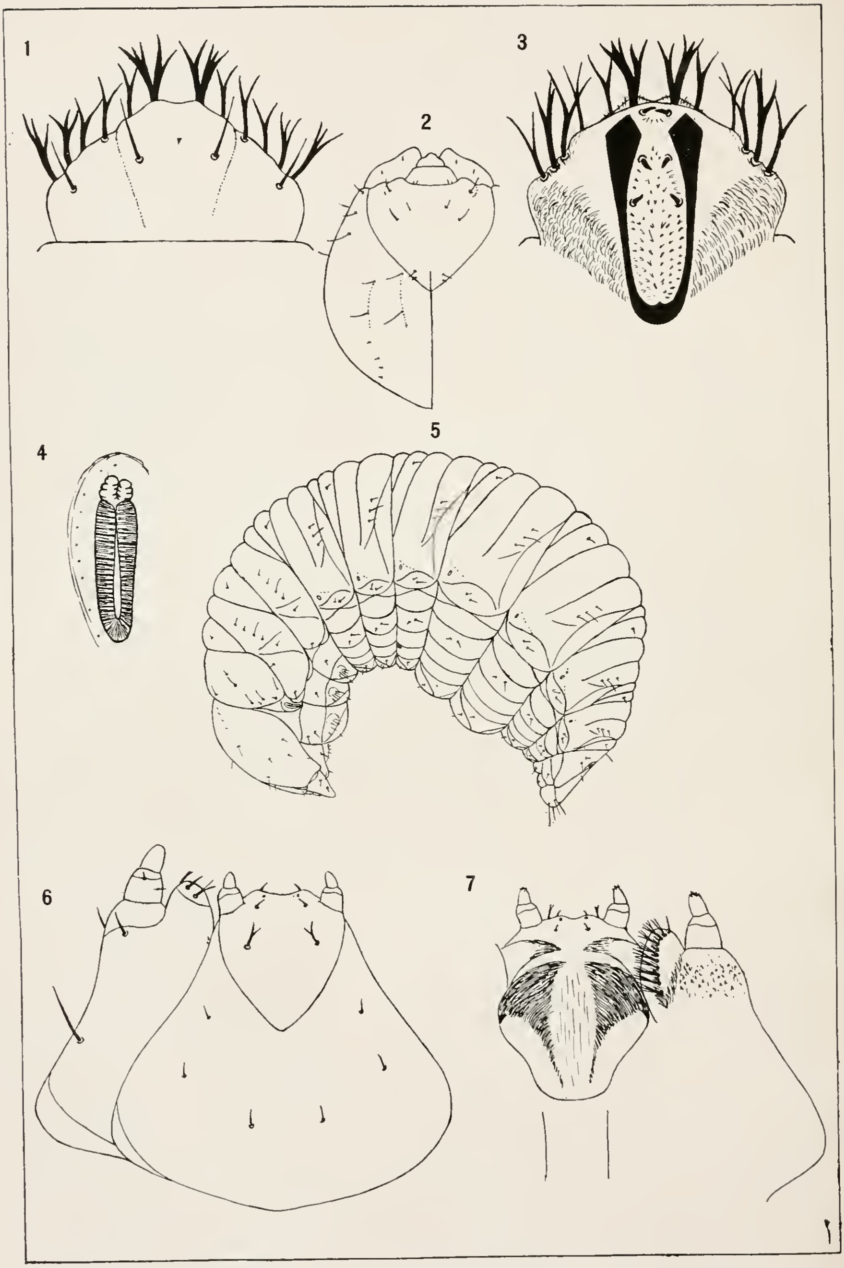
DETAILS OF RHODOBAENUS TREDECIMPUNCTATUS (ILLIGER)

FOR EXPLANATION OF PLATE SEE PAGE 9



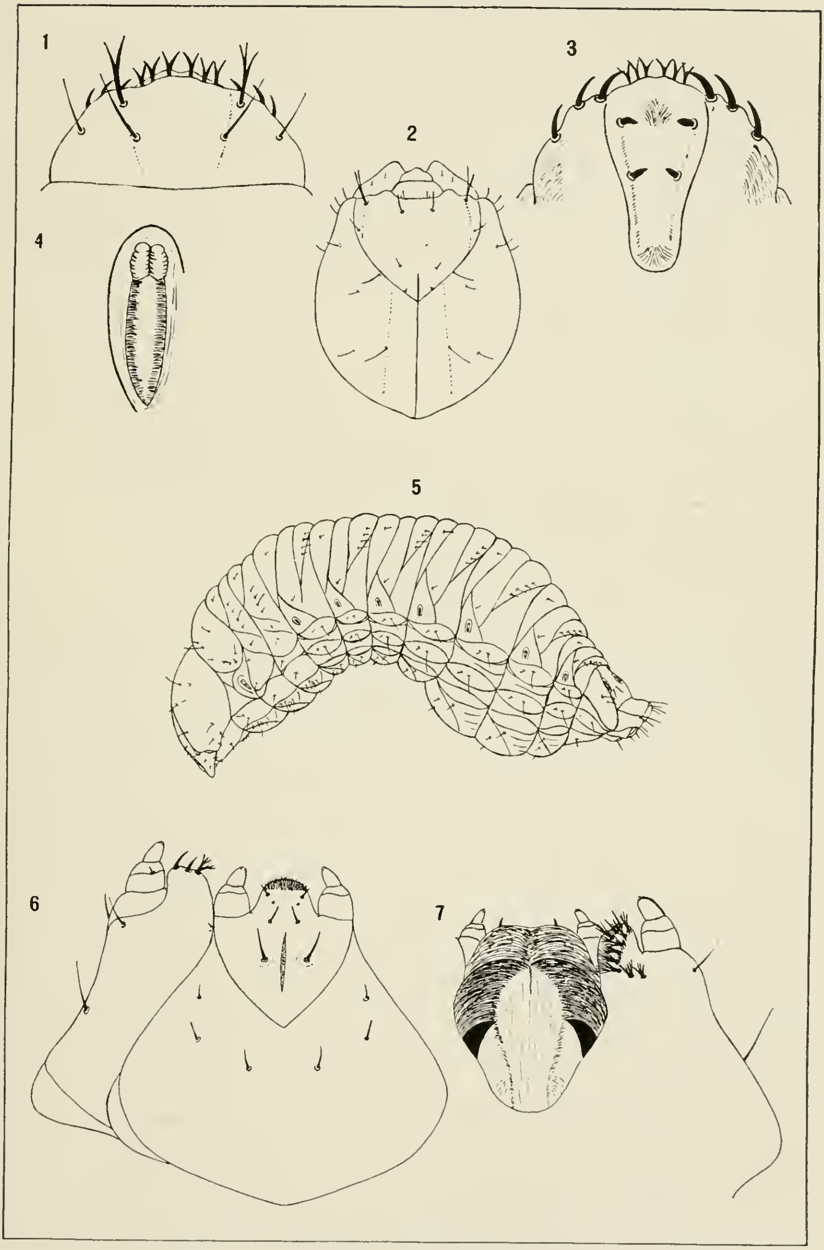
DETAILS OF SITOPHILUS GRANARIUS (LINNAEUS)

FOR EXPLANATION OF PLATE SEE PAGE 9



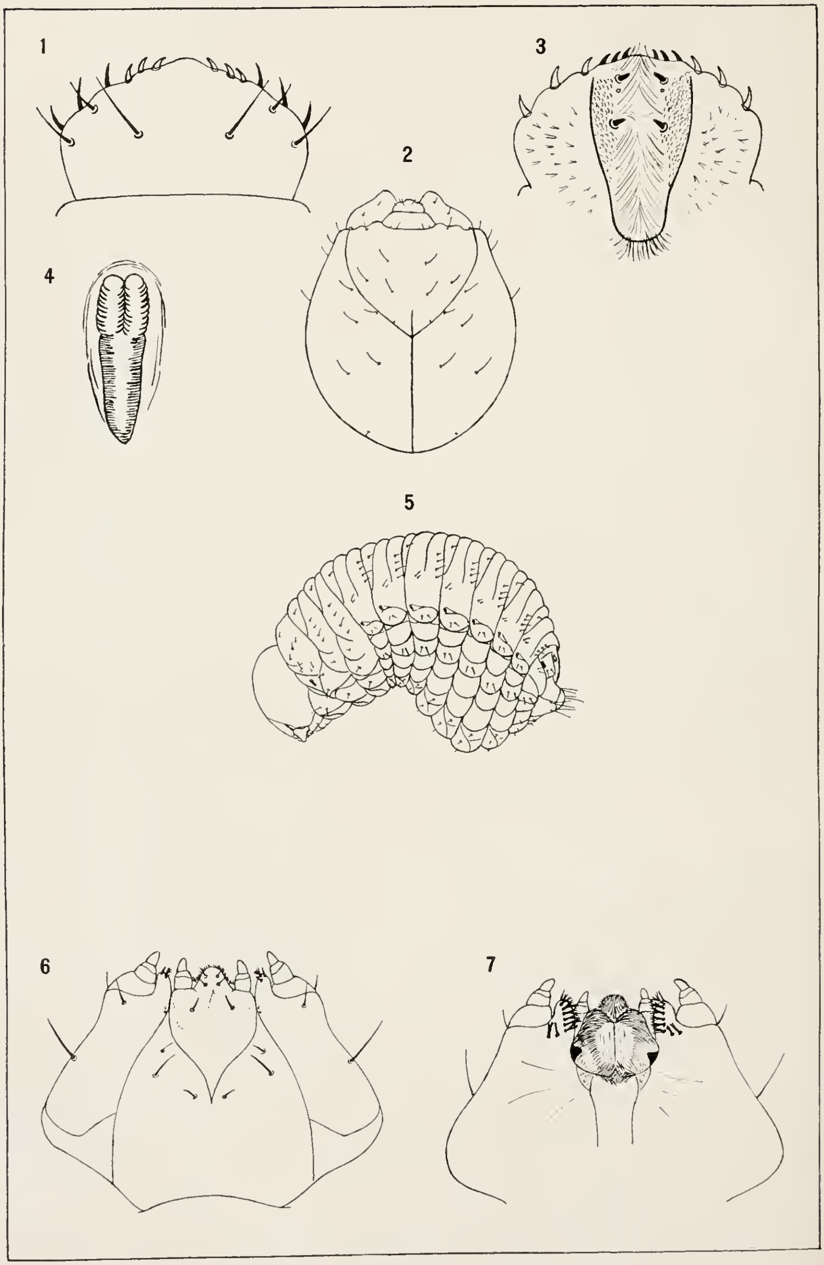
DETAILS OF COSMOPOLITES SORDIDUS GERMAR

FOR EXPLANATION OF PLATE SEE PAGE 10



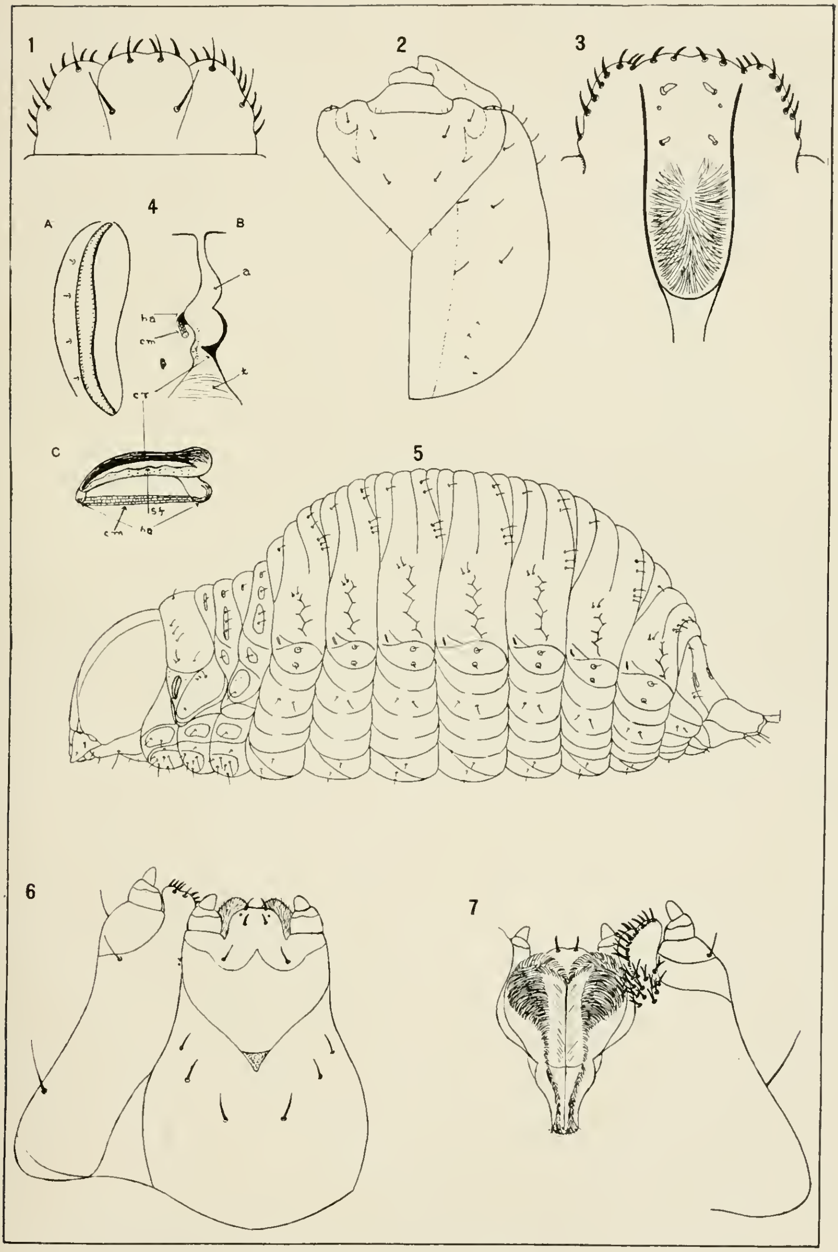
DETAILS OF METAMASIUS SERICEUS (LATREILLE)

FOR EXPLANATION OF PLATE SEE PAGE 10



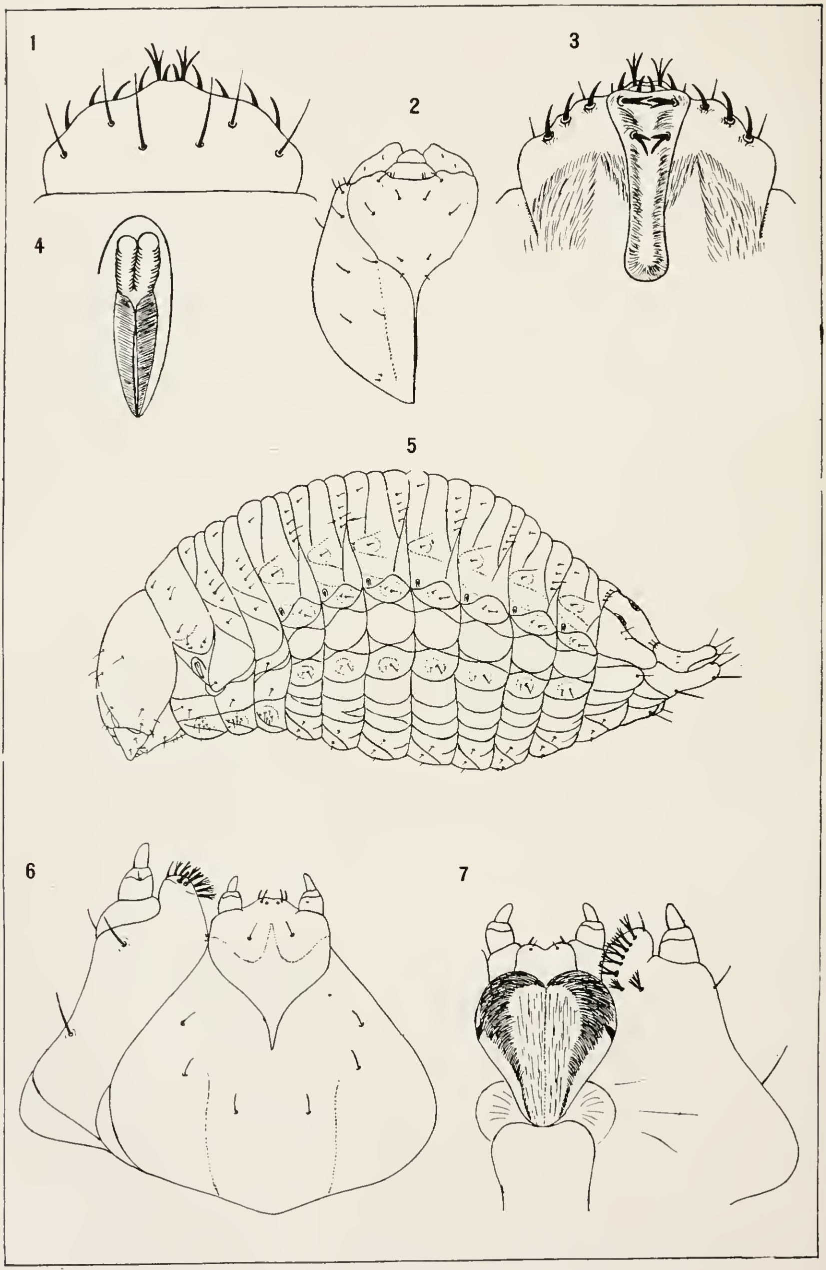
DETAILS OF CALENDRA CALLOSUS (OLIVIER)

FOR EXPLANATION OF PLATE SEE PAGE 10



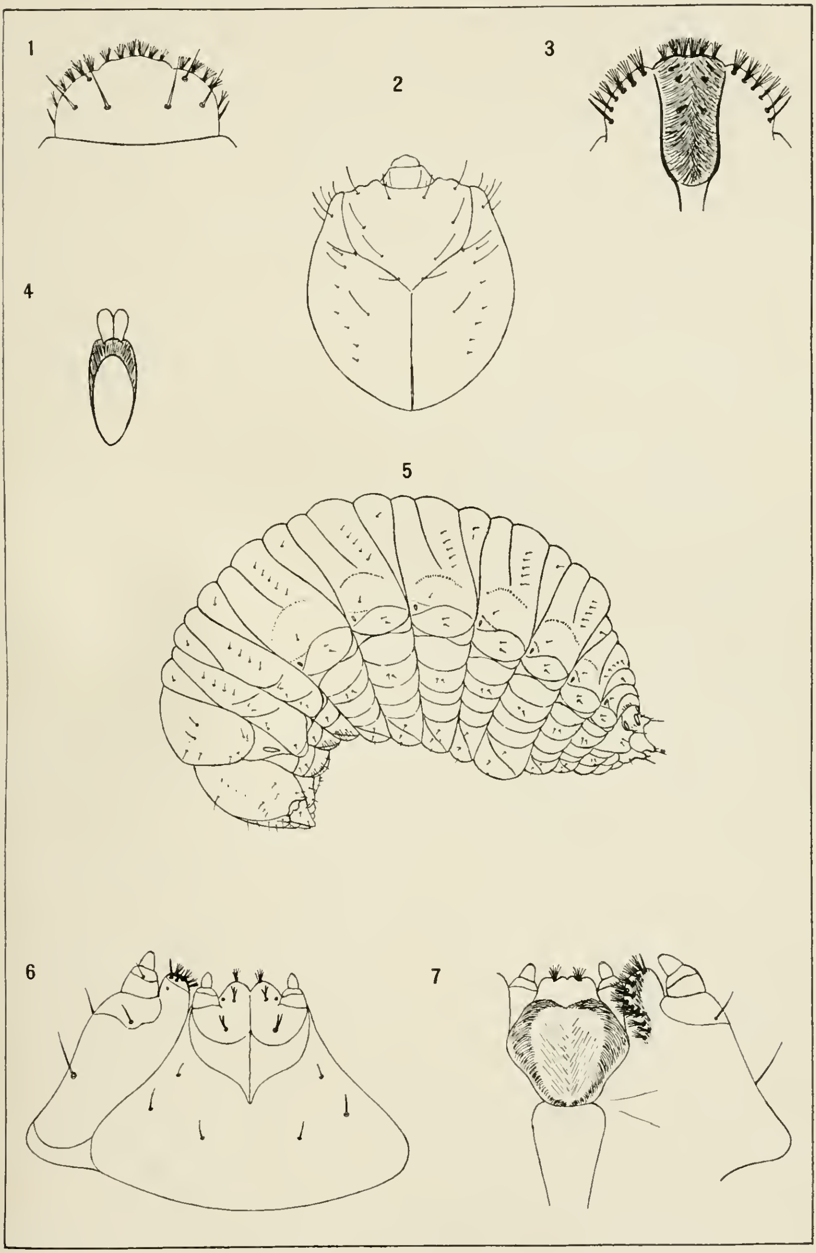
DETAILS OF RHYNCHOPHORUS CRUENTATUS (FABRICIUS)

FOR EXPLANATION OF PLATE SEE PAGE 10



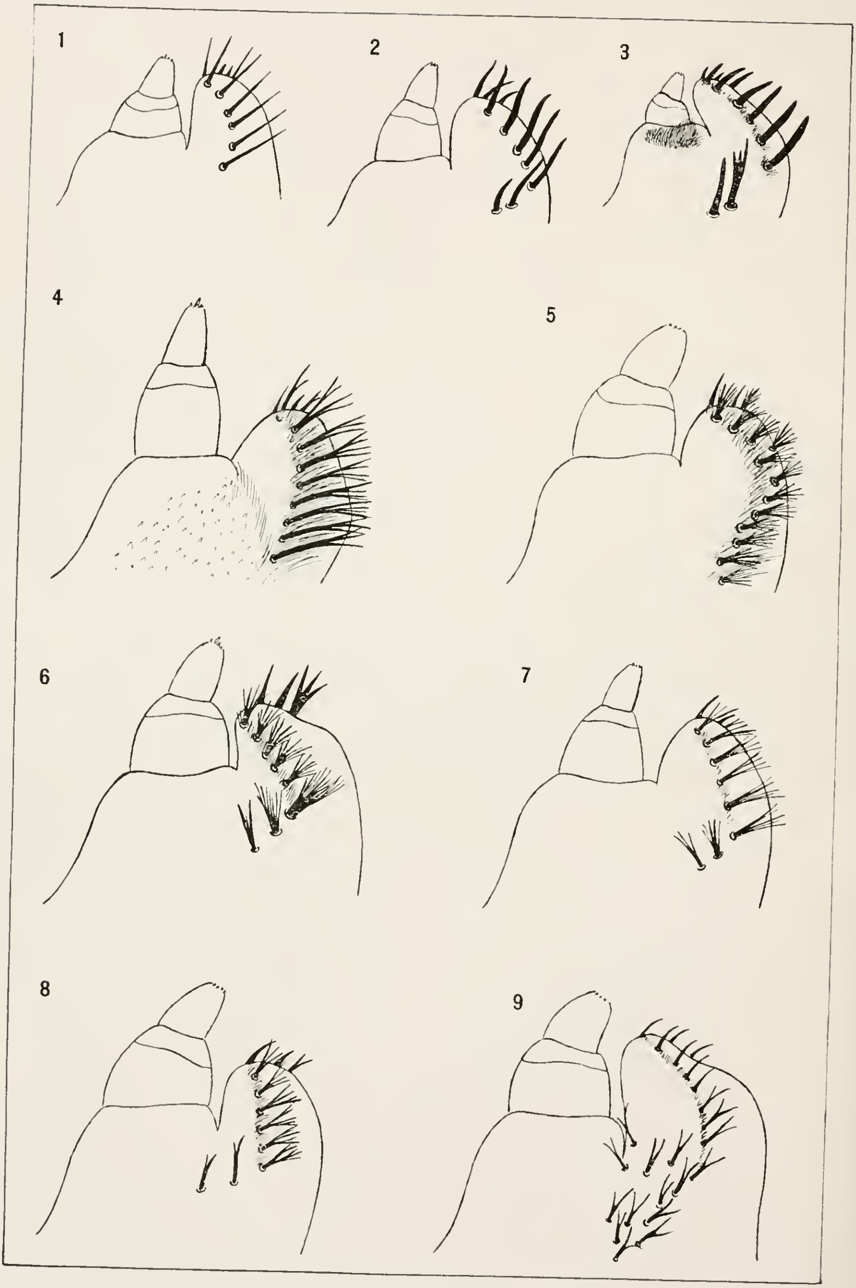
DETAILS OF SCYPHOPHORUS ACUPUNCTATUS (GYLLENHAL)

FOR EXPLANATION OF PLATE SEE PAGE 11



DETAILS OF THE GENUS YUCCABORUS LECONTE

FOR EXPLANATIION OF PLATE SEE PAGE 11



BUCCAL CHARACTERS OF CALENDRINAE

FOR EXPLANATION OF PLATE SEE PAGE 11

NOTES ON THE HERPETOLOGICAL COLLECTIONS MADE BY DR. W. L. ABBOTT ON THE ISLAND OF HAITI

By Doris M. Cochran

Aid, Division of Reptiles and Batrachians, United States National Museum

For the past thirty-five years Dr. W. L. Abbott has enriched the collections in the United States National Museum by frequent contributions of the results of his collecting expeditions in various parts of the world. Since 1916 he has turned his attention particularly to the island of Haiti, from which he has sent much valuable material, including many new or rare species of animals and plants.

During the summer and autumn of 1916 Doctor Abbott collected natural history specimens on the Samana Peninsula in northeastern Santo Domingo. This trip proved so beneficial to the needs of the National Museum that Doctor Abbott has returned to the island each year. His second trip was made during the first six months of 1917 when he secured many specimens from Tortuga Island and from the northern and northwestern parts of the Republic of Haiti. In November of the same year he made a third trip, this time covering southwestern Haiti and Cayemites Island. From February to October, 1919, he visited the Samana Peninsula once more, and worked to the southwest toward Duvergé. In the spring and early summer of 1920, Doctor Abbott visited Gonaives Island and some small villages in the vicinity of Furcy, Haiti. The three expeditions taken since that time have all been to the Samana Peninsula, from which district very rich collections have been secured where formerly few specimens had been obtained.

ELEUTHERODACTYLUS WEINLANDI Barbour

One specimen (U.S.N.M., No. 65709) collected at Las Cañitas on February 27, 1923; one (No. 65054) at Laguna in May, 1923, and three (Nos. 65706–65708) at Samana and Laguna in March, 1923. Our specimens agree in color-pattern with the figure published by Schmidt,[1] but the disks on the toes of our specimens are somewhat larger than those of the figured specimen.

[1] Bull. Amer. Mus. Nat. Hist., 1921, vol. 44, art. 2, p. 8.

ELEUTHERODACTYLUS FLAVESCENS Noble

Nine specimens (U.S.N.M., Nos. 65697–65705) collected at Samana and Laguna in March, 1923. Of these, seven are young, but the skin is fully as warty as in the adult.

ELEUTHERODACTYLUS ABBOTTI Cochran

The type (U.S.N.M., No. 65055) and two paratypes (Nos. 65056 and 65057) collected at Laguna, Samana Peninsula, in May, 1922. Twenty-five more specimens were secured at Samana and Laguna in March, 1923. Out of the twenty-five, eleven resemble the type in having a very definite white line beginning at the snout, bifurcating above the vent and continuing on the posterior femur, on the distal half of the tibia and to the sole of the foot. The remaining fourteen specimens lack the white line, although there is the same distinct mid-dorsal ridge in the skin from snout to vent, which in the typical specimens appears without pigment. The largest specimen (No. 65683) measures 21 mm. from snout to vent.

ELEUTHERODACTYLUS MONTANUS Schmidt

Eleven specimens (U.S.N.M., Nos. 60627–60635, 60650–60651) collected in Moron during December, 1917.

ELEUTHERODACTYLUS SCHMIDTI Noble.

One specimen (U.S.N.M., No. 60626) collected in Moron on December 23, 1919.

ELEUTHERODACTYLUS INOPTATUS (Barbour)

Seven specimens (U.S.N.M., Nos. 65022–65027, 65089) from Laguna taken in May, 1922; one (No. 65721) from Samana and Laguna taken in March, 1923; three (Nos. 65722–4) from Las Cañitas taken February 27, 1923; two (Nos. 55085–55086) taken in 1916, no definite locality other than Santo Domingo.

ELEUTHERODACTYLUS RUTHAE Noble

Four specimens (U.S.N.M., Nos. 65710–65713) from Jovero taken February 4 and 5, 1923; seven (Nos. 65714–65720) taken at Samana and Laguna in March, 1923.

LEPTODACTYLUS DOMINICENSIS Cochran

The type (U.S.N.M., No. 65670) was taken at Las Cañitas on February 25, 1923. This is probably the most important of the herpetological discoveries made by Doctor Abbott. Two more specimens (Nos. 66675–6) received after the foregoing list was made, show a very definite color pattern on the dorsal surface. These two frogs were collected four miles west of Jovero on December 4, 1923, from a muddy gully in the forest.

HYLA VASTA Cope

One adult male (U.S.N.M., No. 65090) taken at Lo Bracito on April 15, 1922, at an altitude of 1,000 feet; eight adult males (Nos. 65752–65759) taken at Liali on February 9 and 10, 1923; one (No. 55301) taken at El Rio on October 8, 1916.

HYLA DOMINICENSIS (Tschudi)

Two specimens (U.S.N.M., Nos. 60637–60638) collected at Jeremie on December 10, 1917; one (No. 60639) at "La Grotte," Jeremie, on December 9, 1917; ten (Nos. 60640–60649) from Moron taken in December, 1917; one (No. 65091) from Lo Bracito collected on April 12, 1922; twenty-seven (Nos. 65028–65039, 65040–65053, 65120) from Laguna taken in May, 1922; one (No. 65725) from Las Cañitas on February 25, 1923; two (Nos. 65726 and 65727) from Liali captured February 9 and 12, 1923; two (Nos. 65728 and 65729) from Samana and Laguna taken in March, 1923; one (No. 64909) from Petit Trou taken February 16, 1922; one (No. 60636) from Jeremie on December 2, 1917; one (No. 61930) from Laguna near Samana on March 10, 1919; six (Nos. 55087–55092) taken in 1916, with no definite locality other than Santo Domingo.

HYLA PULCHRILINEATA Cope

Thirty-one specimens (U.S.N.M., Nos. 65658–65688) from Laguna taken May 11 to May 15, 1922; twenty-two (Nos. 65730–65751) from Laguna and Samana taken in March, 1923.

HEMIDACTYLUS MABOUIA (Moreau de Jonnès)

One specimen (U.S.N.M., No. 65782) from Samana and Laguna, Samana Peninsula, collected in March, 1923; one specimen (No. 65783) from Jovero, collected February 6, 1923.

ARTISTELLIGER LAR Cope

One specimen (U.S.N.M., No. 62362) from Sanchez, taken on August 23, 1919.

SPHAERODACTYLUS DIFFICILIS Barbour

One specimen (U.S.N.M., No. 65781) from Samana and Laguna collected in March, 1923. Doctor Barbour has compared this specimen with the type in the Museum of Comparative Zoology. He writes that this specimen (33 mm. from snout to vent) is larger than any of his specimens, but with no differences from the type not due to size and age.

SPHAERODACTYLUS TORREI Barbour

One specimen (U.S.N.M., No. 60617) from Haiti, taken in the winter of 1917–18. This lizard has also been examined by Doctor Barbour. He says that it is just like a specimen in the Museum of Comparative Zoology (No. 13481) from Thomazeau, Haiti.

ANOLIS RICORDII Duméril and Bibron

Four specimens (U.S.N.M., Nos. 55048–55051) from Santo Domingo collected in 1916; one specimen (No. 55302) from El Rio taken October 8, 1916; two more (Nos. 62104–62105) from the same place taken May 13 and 19, 1919; one specimen (No. 61928) from Cayo Hondo, Samana Bay, collected in February, 1919; one specimen (No. 61929) taken in 1919 at Laguna near Samana.

ANOLIS DISTICHUS Cope

Ten specimens (U.S.N.M., Nos. 55058–55067) from Rojo Cabo near Cape Samana, collected August 28–31, 1916; one specimen (No. 60625) from Jeremie taken December 10, 1917; one specimen (No. 65769) from Jovero collected on February 16, 1923.

ANOLIS CYBOTES Cope

Three specimens (U.S.N.M., Nos. 65763–5) from Jovero collected on February 19, 1923; two specimens (Nos. 65766–65767) from Liali taken February 10 and 15, 1923; three specimens (Nos. 55303–55305) from Jarabacoa collected October 16, 1916; seventeen specimens (Nos. 55068–55084) from Rojo Cabo taken August 28–31, 1916; one specimen (No. 60624) from Moron taken December 20, 1917; one specimen (No. 65768) from Santo Domingo taken in 1923. None of these specimens have any indications of keels on the ventral scales.

ANOLIS CHLOROCYANUS Duméril and Bibron

Two specimens (U.S.N.M., Nos. 65761–65762) from Jovero collected on February 19, 1923; one specimen (No. 65762) from Liali taken February 10, 1923.

ANOLIS OLSSONI Schmidt

One specimen (U.S.N.M., No. 62103) from the hills 5 miles south of Constanza, collected on April 29, 1919, is referred to this species. Its total length is 160 mm.; the tail 121; the tip of snout to the ear 10.5; the body 28.5. A paratype (Amer. Mus. Nat. Hist., No. 15300), which is now before me, differs from the figure of the type specimen [2] in the following points: The paratype has a row of scales separating the supraorbital semicircles from each other, while in the type these semicircles are in contact. In the paratype, the enlarged supraoculars are quite smooth, and the scales between the supraoculars and the anterior supraciliaries are relatively large; in the figure of the type, the supraoculars are shown to be keeled, and the scales between them and the anterior supraciliaries are relatively small, almost granular. The scales between the occipital and the posterior por-

[2] Notes on the Herpetology of San Domingo, Schmidt, Bull. Amer. Mus. Nat. Hist., 1921, vol. 44, art. 2, p. 11.

tion of the supraorbital semicircles are small in the figure, but relatively larger in the paratype. In comparing our specimen from Constanza (No. 62103) with the paratype, I find the following discrepancies: The temporal region in the paratype is covered with very fine granules; in No. 62103 these granules are much coarser, although this is the smaller specimen (the paratype measures 42 mm., and No. 62103, 39 mm.). The supraorbital semicircles are separated rather widely in the paratype, but in contact anteriorly in No. 62103. The supraoculars in No. 62103 have low keels, and the scales lying in front of them are very small, in these respects agreeing with the figure of the type but disagreeing with the paratype. The outline of the snout when viewed from above is nearly the same in the figured type and in No. 62103. The snout of the paratype, however, seems much longer in proportion to the width of the head, and this observation holds also in comparing the profiles of No. 62103 and the paratype. In nearly all aspects No. 62103 seems to resemble the figure of the type far more closely than it resembles the paratype. If the paratype be a true *olssoni*, then the species is certainly extremely variable. I am convinced, however, that the paratype is not a true *Anolis olssoni*, a conviction which is also shared by Doctor Ruthven, who has examined the specimens now under discussion.

CYCLURA RICORDII (Duméril and Bibron)

In 1789 Abbé Bonnaterre described an iguana with a remarkable frontal horn, calling it *Lacerta cornuta*.[3] The specimen upon which the description was based was taken in 1784 "dans les mornes de l'hôpital, entre l'Artibonite et les Gonaives," Santo Domingo (now the Republic of Haiti). This same specimen was described in more detail by Duméril and Bibron[4] under the name of *Metopoceros cornutus*, and since their time the species has come to be fairly well known to science. Doctor Abbott has sent to the National Museum a good series of these lizards, which will be discussed in detail a little later in this paper.

Another large iguanid lizard collected in Santo Domingo by M. Alexandre Ricord and sent by him to the Museum of Natural History in Paris was described by Duméril and Bibron in the same work[5] as the monotype of a new genus, *Aloponotus ricordii*. This species also was based upon a single skin, which until 1919 remained unique. In that year Doctor Abbott sent home a skin of a rock iguana which agrees in most respects with Duméril and Bibron's description of *Aloponotus ricordii*. Doctor Stejneger exhibited this skin at a meeting of the Society of Ichthyologists and Herpetologists

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[3] Tabl. Enc. Méth. Erp., p. 40, pl. 4, fig. 4.
[4] Erp. Gén., vol. 4, 1837, p. 211.
[5] Idem, p. 190.

on May 14, 1920. It is due to Doctor Abbott's rediscovery that the old name of *Aloponotus ricordii* may now be taken out of the synonymy of *Cyclura cornuta*, where it was placed provisionally by Boulenger.[6]

As the specimen upon which the original description was based was in very poor condition, it will not be amiss to furnish a complete description of the one in our collection.

Description.—Adult, male, U.S.N.M., No. 62557, Duvergé, Santo Domingo; October 3, 1919; W. L. Abbott, collector. Rostral wide, as wide as mental, broadly in contact with nasals; nasal large, irregularly rectangular, slightly higher than wide, perforated by a round nostril equal in diameter to one-half the height of the rostral; postnasal large, two-thirds size of nasal and broadly in contact with it; nasals in contact with each other in middle line of snout behind rostral for about half their width, when they are separated by a single, flat, triangular shield; no conical, horn-like scales on snout; the top of the head covered by irregularly polygonal shields, rather larger and wrinkled on snout, more tubercular on frontal region, and similar but smaller in interorbital space; interorbital scales in 5 rows; supraocular semicircles evident, though the component keeled scales hardly exceed the similar scales which form the supraorbital disk; occipital region only slightly elevated above supraorbital region; semicircles separated by about 4 rows of smaller tubercular scales; occipital scale two-thirds height of rostral, located between posterior borders of semicircles from which it is separated by 2 rows of scales; a series of moderately keeled suboculars continued backwards as a supratympanic series to above the ear; shields very small and tubercular above and below the posterior half of this series; 7 or 8 supralabials to a point beneath the center of the eye; a series of small scales separating the suboculars and supralabials; tympanum elliptical, erect, large; 7 or 8 lower labials to center of eye; a series of enlarged malar scales, the posterior ones moderately keeled and separated from the lower labials by one or two rows of flat scales as large as the anterior malars; dorsal and ventral scales rhomboidal, obliquely keeled, the keels pointing toward the median line; dorsal scales very small, about 110 scales measured posteriorly from the axillary contained in the distance from end of snout to anterior edge of tympanum; ventral scales slightly larger than dorsals and more distinctly keeled; from the occiput along the median line of the neck and back a series of enlarged, strongly keeled scales forming a high serrated crest which is much reduced on the shoulders and on the rump but is continuous with the caudal crest; scales of nuchal crest

[6] Cat. Liz. Brit. Mus., vol. 2, 1885, p. 1881.

narrower and appreciably longer than those of dorsal crest; height of the crest-scales on the middle of the back $1\frac{1}{4}$ times the height of the rostral, 6 to the distance from end of snout to anterior edge of tympanum; about 35 scales in the dorsal crest between shoulder and rump; throat covered with scales similar to the ventrals but smaller; sides of neck with numerous folds; a large transverse fold underneath neck and a longitudinal one on each side of the body; upper surface of front limbs and femur of hind limbs with slightly imbricated, keeled scales, much larger than the dorsals; on the lower arm about 50 to the distance from the end of snout to anterior edge of tympanum; on the front of the tibia from the knee half way to the foot the scales greatly increasing in size, each bearing a long, sharp spine pointed backwards, partly surrounded by small, irregularly placed shields bearing a small spine; scales abruptly diminishing in size on the back of the leg; a single series of 18 femoral pores; inner side of second toe with one comb, of third toe with two combs, the proximal one being much the larger; a tendency to form 3 combs on the fourth toe; nails long and sharp; tail covered with large obliquely keeled scales in vertical rows forming prominent verticils which on the half of the tail nearest the body become spiny and very much enlarged between the fifth and tenth scales, counting transversely from the caudal crest; about 3 rows of scales between verticils at their greatest enlargement and 5 near the caudal crest and beneath the tail where the verticils are less prominent; verticils becoming less well-marked toward extremity of tail.

Dimensions

	Mm.
Total length	756
Tip of snout to vent	326
Vent to tip of tail	430
Tip of snout to ear	70
Width of head	50
Fore limb	136
Hind limb	186
Vertical diameter of tympanum	12

Coloration: Head and nuchal region light; throat black; forelimbs black above, lighter underneath; a light patch on shoulder bordered behind with dark extending to base of nuchal crest; on the back a pattern of about 9 light bands bordered with dark arising from the dorsal crest; five of these extending obliquely downward on sides; pattern indistinct on sides becoming marked beneath in 5 or 6 dark transverse streaks alternating with broader bands of light; sides, back and anterior surface of femur spotted with black; hind legs and tail light.

Doctor Stejneger has given me permission to use his notes on the differences between our specimen and the description of the type. He says:

The principal characters relied upon for the diagnosis of *Aloponotus ricordii* were (1) the alleged lack of scales on the upper part of the body; (2) a small dewlap on the foreneck; (3) a long double row of femoral pores; (4) a verticillated tail with spines at certain intervals; (5) small, equal, polygone plates on top of the head.

The alleged absence of scales on the back is emphasized by the authors' saying, "The saurian, for which we establish this genus, is the only one we know of which has almost the entire upper surfaces of the body devoid of scales * * *. The skin of these regions resembles that of some sharks * * *. Examined under the lens the surface seems covered with very small granules extremely 'serrés les uns contre les autres.'" Unfortunately the figure given by the authors on Plate 38 flatly contradicts this description showing, as it does, the entire back and sides covered with rather large, nearly uniform, rhomboidal scales. In addition this same figure shows a verticillate tail with a homogeneous scutellation and without the spiny rings as described in the text. This discrepancy between the description and the illustration has contributed largely to the discredit and oblivion into which this species has fallen.

With regard to the alleged unique lack of scales on the back, Cope has shown[7] that in certain specimens of *Metopoceros* in the island of Navassa, the dorsal scales or granules vary in size from being minutely granular in some places to forming distinct scales everywhere. Duméril and Bibron's own description, moreover, shows that by the expression "skin entirely devoid of scales" they did not mean that the skin was naked, only that the "scales" were reduced to very small granules. Our specimen has a single row of femoral pores, while the lepidosis on the back is that of very small scales without keels, rather than granules. The latter character, as we have seen in another form of the same genus, seems to be a variable one, and as for the femoral pores, we know that the additional series is of no systematic importance, one or two rows being found in several species.

Dr. G. K. Noble, of the American Museum of Natural History, succeeded in capturing alive a number of these lizards, which he brought back to New York in 1922. Some observations on the habits and coloration of the living animals would be very interesting.

CYCLURA CORNUTA (Bonnaterre)

One adult male (U.S.N.M., No. 65139 from Trujin taken February 19, 1922, measured 1,410 mm. in length, the head and body being 640 mm. Another male (No. 60599) from Cayemite Island, captured January 13, 1918, measured 1,035 mm., the tail being 530 mm. long. From the same island, taken the same day, another male (No. 60600) was 1,030 mm. in length, the tail being 490 mm., according to notes made by Doctor Abbott. A female (No. 60601) was taken at the same place on January 11, 1918. Three specimens (Nos. 62558–

[7] Proc. Amer. Philos. Soc., vol. 23, 1886, p. 263.

62560) were taken at Duvergé on October 2, 1919, the first two females, the last a male measuring 1,055 mm. in length. A specimen (No. 63112) was secured off Petit Gonaive Island on July 10, 1920. A very young specimen from Tortuga captured February 1, 1917, measures only 112 mm. from snout to vent.

I have noticed very great variation in the arrangement of the scales on the snout, and I do not think that specific characters can be found there. The conditions in each specimen are given briefly as follows:

No. 59455.—Nasals and rostral narrowly in contact on the right side, separated by small scales on the left side; frontal and prefrontals separated by two rows of small scales.

No. 60599.—Nasals and rostral separated by medium-sized scales; frontal and prefrontals separated on the right side by numerous small granules, on the left side by two rows of small scales.

No. 60600.—Nasals and rostral separated by a row of medium-sized scales; frontal and prefrontals in close contact.

No. 60601.—Nasals and rostral separated by one row of medium-sized scales; frontal and prefrontals in contact on the right side, separated by a narrow strap-like scale on the left side.

No. 62588.—Nasals and rostral in contact rather broadly on both sides; frontal and prefrontals separated by one row of very narrow scales.

No. 62559.—Nasals and rostral separated by a row of rectangular medium-sized scales; frontal and prefrontal separated by a row of moderate-sized polygonal scales and an additional row of very narrow strap-like scales which encircle the base of the frontal horn.

No. 62560.—Nasals and rostral in contact, rather broadly so on the left side, narrowly on the right side; frontal and prefrontals in close contact.

No. 63112.—Nasals and rostral separated on the right side by medium-sized scales, on the left side by a very narrow scale; frontal and prefrontals widely separated by two rows of polygonal scales.

No. 65139.—Nasals and rostral narrowly in contact on the right side, separated by a row of very small scales on the left side; frontal and prefrontals separated by a row of very narrow scales.

LEIOCEPHALUS MELANOCHLORUS Cope

One specimen (U.S.N.M., No. 60621) from Jeremie, Haiti, collected November 22, 1917.

LEIOCEPHALUS SCHREIBERSII (Gravenhorst)

Thirteen specimens (U.S.N.M., Nos. 59442–59454) from Tortuga Island collected on January 30, 1917. These specimens agree well with Haitian examples in our collection.

LEIOCEPHALUS PERSONATUS Cope

Nine specimens (U.S.N.M., Nos. 65770–65773, 65775–65779) collected during February, 1923 at Jovero.

CELESTUS SEPSOIDES (Gray)

Three specimens (U.S.N.M., Nos. 65784–65786) from Samana and Laguna collected in March, 1923. These very rare skinks are a welcome addition to the collection in the National Museum.

CELESTUS COSTATUS (Cope)

One specimen (U.S.N.M., No. 60622), from 8 miles southwest of Jeremie, collected on December 9, 1917; one (No. 60623) from Moron taken December 20, 1917; two (Nos. 61931–61932) from Laguna, near Samana, taken March 10 and March 7, 1917; three (Nos. 62361, 62363–62364) from Sanchez captured August 11 and 12, 1919; one (No. 65780) from Las Cañitas taken February 23, 1923; two (Nos. 55056–55057) from Santo Domingo taken in 1916; one (No. 59435) from Rivier Bar, north Haiti, collected February 21, 1917. This last specimen is badly mutilated about the head, so that the relation in the size of the interparietal and parietals can scarcely be distinguished. It seems, however, that the interparietal is smaller than the parietals, and this would exclude it from Cope's *C. rugosus*, the type of which is here in the National Museum. The Rivier Bar specimen has very heavily keeled scales, but as the lizard is a very large one, the largest in our collection, the keels are probably due to its size and age.

AMEIVA TAENIURA Cope

Four specimens (U.S.N.M., Nos. 55052–5) from Santo Domingo collected in 1916; one (No. 65018) from Laguna, Samana Peninsula, taken in May, 1922.

AMEIVA CHRYSOLAEMA Cope

One specimen (U.S.N.M., No. 59925) from Moustique Bay collected May 3, 1917; one (No. 60618) from Lake Assuei taken March 10, 1918; one (No. 60619) from Trou Caiman taken March 11, 1918; one (No. 59434) from Tortuga Island captured January 31, 1917. The specimen from Tortuga is slightly different from the Haitian examples, as it has only three supraoculars instead of four. Between the frontoparietals and the third supraocular of the Tortuga specimen there are small scales distinctly larger than the granules which are found in the other specimens. Without additional material to prove that these differences are constant, I do not think it advisable to describe a new species from Tortuga Island.

AMPHISBAENA INNOCENS Weinland

One specimen (U.S.N.M., No. 60620) from Moron taken on December 25, 1917, has 2 scales behind the postmental, 211 rings around the body, and 15 rings around the tail.

TYPHLOPS PUSILLUS Barbour

A single specimen (U.S.N.M., No. 64271) taken from the stomach of a snake (*Leimadophis parvifrons*, U.S.N.M., No. 64270) collected in the Mao-Yaqui Valley in 1921. In spite of having been swallowed by the larger snake, the worm-snake is in good condition, and it is easy to see that the cephalic squamation agrees with Barbour's figure of the type of the species.[8] There are 20 scales around the body, about 380 scales on the midventral line from the chin to the vent, and about 16 under the tail, which terminates in a spine.

TYPHLOPS LUMBRICALIS (Linnaeus)

One specimen (U.S.N.M., No. 55298) was taken at Sanchez, Santo Domingo, in October, 1916.

EPICRATES STRIATUS (Fischer)

One specimen (U.S.N.M., No. 59436) from Bombardopolis, captured on March 28, 1917, at an altitude of 1,500 feet; one (No. 59437) from Tortuga Island taken February 1, 1917; two (Nos. 59918–59919) from Port au Prince, Haiti, taken April 16 and 17, 1917, the former a female which contained 11 eggs, the latter a male; one (No. 60603) from Moline taken January 28, 1918, at an altitude of 2,000 feet; one (No. 60604) from Les Basses on January 9, 1918; two (Nos. 55044–55045) with no precise locality other than Santo Domingo, collected in 1916. The ring of scales around the eye is incomplete in all the specimens except one (No. 60604) in which there is a small subocular scale completing the circle on the right side only, the left having a supralabial reaching the eye. In none of these specimens do three labials enter the eye, as is the case in the Cuban *E. angulifer;* the majority of the Santo Domingan snakes have two labials reaching the eye, and in a slightly lesser number only one labial reaching the eye. When the loreal itself is divided (as in Nos. 59436, 59437, and 59919) there are two scales intercalated above the upper labials; when the loreal is whole, there is but a single intercalated scale (in two instances none at all on one side of the head) between the loreal and the upper labials.

The specimen from Tortuga Island does not seem to differ specifically from the Haitian form. There are 55 scales around the body, 286 ventrals, a divided anal and 63 caudals (tail defective). There

[8] Mem. Mus. Comp. Zool., vol. 44, No. 2, p. 323.

are 17 supralabials on each side of the mouth, but as two from Haiti (Nos. 59436 and 60603) have 16, this discrepancy with Boulenger's description seems very slight.

EPICRATES GRACILIS (Fischer)

One specimen (U.S.N.M., No. 55026) was captured at Rojo Cabo, Samana Peninsula, Santo Domingo, on August 29, 1916. This specimen, the only representative of this rare species in the collection of the National Museum, has 39 scale rows around the body, 274 ventrals, 60 caudals (the tail is defective), 12 upper labials on the right side and 13 on the left. The coloration (in alcohol) is as follows: The head purplish-brown, becoming lighter on the upper labials and on the neck; a few indistinct darker markings on the occiput and temporal region; the body brown, with a series of roundish black spots about five scales long on each side of the mid-dorsal line; these spots separated from each other by brown interspaces about three scales in length; saddle-like blotches across the back often formed by confluent spots of the two series; two lateral series of smaller black spots on each side; the larger series very irregular in shape, occupying the four or five outer scale rows; the inner and smaller series usually on the sixth, seventh, and eighth rows and sometimes anastomosing with the outer series; the throat pale yellow; the ventral surface light anteriorly, becoming posteriorly more and more suffused with gray mottlings until only the edge of each ventral and caudal scale remains light; a few dark spots scattered irregularly near the ends of the ventrals and on the caudals. The snake is not large in size, being 700 mm. in length from the snout to the end of the tail, which is incomplete.

TROPIDOPHIS CONJUNCTUS Fischer

One specimen (U.S.N.M., No. 55046) taken near Cape Samana on August 30, 1916. This snake has 27 scales around the body, 186 ventrals, an undivided anal, and 35 caudals. It differs from the figure of the type specimen [9] in having two pairs of praefrontals, the second pair the smaller, instead of only one pair. In the type specimen, fusion has probably taken place, and the occurrence of two pairs of praefrontals is apparently the normal condition. In No. 55046 the frontal is relatively shorter than in the figured specimen, but the difference is not great enough to warrant specific distinction.

TROPIDOPHIS MACULATA HAETIANA Cope

One young specimen (U.S.N.M., No. 64910) was taken at Paradis, near Barahona, in 1922. This snake has 27 scale-rows around the body. There is a very tiny scale between the parietal shields.

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[9] Jahrb. Hamb. Wiss. Anst., vol. 5, 1888, p. 31, pl. 3, fig. 5.

UROMACER CATESBYI (Schlegel)

One specimen (U.S.N.M., No. 55299) taken at Sanchez, Santo Domingo, on October 26, 1916; one (No. 63115) from Gonaives Island on March 16, 1920; one (No. 63116) at Etang Saumatre on May 6, 1920; two (Nos. 63598–63599) taken at Laguna on December 20, 1920; two (Nos. 65019–65020) taken at the same place in May, 1922; three (Nos. 61925–61927) taken near Samana in March, 1919; six (Nos. 55033–55038) with no other definite locality than Santo Domingo taken in 1916. The specimen from Gonaives Island has 17 scale-rows around the body, 172 ventrals, a divided anal, and 72 caudals (part of the tail missing). As in *U. catesbyi* from Haiti, the snout is twice as long as the eye, and the rostral shield is twice as broad as deep.

UROMACER SCANDAX Dunn

The type, an adult female (U.S.N.M., No. 59438), was taken January 31, 1917, on Tortuga Island.

UROMACER OXYRHYNCHUS Duméril and Bibron

Five specimens (U.S.N.M., Nos. 55039–55043) from Santo Domingo taken in 1916; two (Nos. 59923–59924) from Tortuga Island captured on May 22 and 23, 1917; five (Nos. 59456–59460) from the same place collected in February, 1917; two (Nos. 59462–59463) from the same place on January 30 and February 3, 1917; one (No. 55300) from Jarabacoa caught October 16, 1916; one (No. 65790) from Samana on March 4, 1923; two (Nos. 63596–63597) from Laguna on December 21, 1921; one (No. 65021) from the same place in May, 1922; one (No. 59461) from Port de Paix on February 27, 1917; one young specimen (No. 65791) taken at Samana and Laguna in March, 1923.

UROMACER FRENATUS (Günther)

One specimen (U.S.N.M., No. 59928) from Tortuga Island taken on April 6, 1917; four (Nos. 60611–60614) from Jeremie, caught in December, 1917, and in January, 1918.

ALSOPHIS ANOMALUS (Peters)

One adult female (U.S.N.M., No. 59917), taken at Jean Ravel on May 8, 1917, contained 22 eggs. This snake has 21 scale-rows, 215 ventrals, and a divided anal. The tail is incomplete. The head and body together measure 1,770 mm. in length.

RACES OF LEIMADOPHIS PARVIFRONS (COPE)

Dr. E. R. Dunn has divided this species into three races.[10] He writes that the typical *parvifrons* comes from the western peninsula of Haiti and is characterized by the very low ventral count. To

[10] Proc. New England Zool. Club, vol. 7, January 20, 1920, pp. 37–39.

this subdivision the first three specimens on the list (Nos. 60607, 60609, and 60610) might be said to belong. The next race, *Leimadophis parvifrons protenus* (Jan) is "the best known of these forms. It was named by Jan, whose specimens came from Port au Prince. Boulenger's specimens also belong to this race, with the exception of one which is of the following form [i. e. *niger*]." The stomach of No. 64270 contained the specimen of *Typhlops pusillus* mentioned above. This young snake (No. 64280) is much less vivid in colring than the other specimens; the dark lateral bands, while quite distinguishable, are more subdued in tone than on the larger specimens. The third race, *Leimadophis parvifrons niger* Dunn, is marked by its melanism. It is probable that the paratypes of Dunn's *L. niger*, labeled simply Santo Domingo, 1916, came from the Samana Peninsula, as Doctor Abbott did most of his collecting in that region in 1916. The two specimens from Laguna (Nos. 63600 and 63601) agree well with the paratypes of this subspecies. The specimen from Liali (No. 65788) has a very distinct light stripe on the fifth and sixth scale-rows. In No. 65787 from Jovero, the ventral scales are lighter than those of the paratypes. In this specimen the black middorsal line is very distinct, and the light stripe on the side is also apparent.

List of specimens

Museum	No.	Sex	Locality	When collected	Ventrals	Caudals	Remarks	
U.S.N.M.	60607		Moline, southwest Haiti	Jan. 31, 1918	148		2,000 feet	*parvifrons.*
	60609		Moron, southwest Haiti	Dec. 22, 1917	146	118		
	60610		do	Dec. 23, 1917	146	117		
	59441	♀	Moustique, northwest Haiti	Mar. 4, 1917	159	112	2,000 feet	*protenus.*
	55306	♀	Jarabacoa, Santo Domingo	Oct. 12, 1916	154		1,800 feet	
	55307	♀	do	do	157	121		
	55308	♀	El Rio, Santo Domingo	Oct. 6, 1916	156		4,000 feet	
	55309	♀	do	do	153		4,000 feet	
	55310	♀	do	do	152		4,000 feet	
	55311	♀	do	Oct. 5, 1916	158		4,000 feet	
	55312	♂	do	do	161	111	4,000 feet	
	55313	♀	Constanza (5 miles north)	Oct. 13, 1916	153	116	4,000 feet	
	55314	♂	do	Oct. 2, 1916	158		4,000 feet	
	55315	♀	do	Sept. 29, 1916	159	114	4,000 feet	
	64270		Mao-Yaqui Valley, Santo Domingo.	1921	163	117		
	65789		Las Cañitas, Santo Domingo	Feb. 25, 1923	157	128		
	55026	♂	Santo Domingo	1916	152	126	Paratypes of *L. parvifrons niger* Dunn.	*niger.*
	55027	♂	do	do	150			
	55028	♂	do	do	155			
	55029	♀	do	do	151			
	55030	♀	do	do	147	125		
	55031	♂	do	do	151	132		
	55032	♀	do	do	155			
	65787		Jovero, northwest Santo Domingo.	Feb. 18, 1923	150	126		
	65788		Liali, northwest Santo Domingo.	Feb. 12, 1923	151	125		
	63600		Laguna, northwest Santo Domingo.	Dec. 23, 1920	153	124		
	63601		do	Dec. 26, 1920	154	124		

LEIMADOPHIS ALLENI Dunn

One specimen (U.S.N.M., No. 60608) from Govaives Island caught on February 25, 1918 has 19 scale-rows around the body, 161 ventrals, a divided anal, and 71 caudals, the tail being defective. On the anterior part of the body the color of scale-rows one and two and the outer half of scale-row three is uniformly light, with a very abrupt change to the black stripe which occupies the inner half of the third, all of the fourth, and nearly all of the fifth. It is not until the middle of the body is reached that the " shading " from the light to the dark tone becomes apparent.

LEIMADOPHIS TORTUGANUS Dunn

The type (U.S.N.M., No. 59440) a female from Tortuga Island taken February 4, 1917; a paratype (No. 59439) a female taken February 7, 1917; a female (No. 59921) taken June 2, 1917. The last-mentioned specimen has 19 scale-rows and 169 ventrals, as in the type; the caudals are 122 in number (the tip of the tail has been broken off). The light edges on the first two scale rows are not noticeable except upon close inspection.

IALTRIS DORSALIS Günther

One adult male (U.S.N.M., No. 59922) from Cape Haitien taken on April 26, 1917; two (Nos. 60605–60606) from Moron captured on December 23, 1917; one specimen (No. 55047) from Santo Domingo collected in 1916.

PSEUDEMYS PALUSTRIS (Gmelin)

One female specimen (U.S.N.M., No. 63096) from Fonds Parisien, Étang Saumatre, Haiti, collected May 4, 1920, and some eggs (No. 63097) from the same place collected on April 14, 1920.

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SOME HITHERTO UNPUBLISHED PHOTOGRAPHS AND MEASUREMENTS OF THE BLUE WHALE.

By Gerrit S. Miller, Jr.,

Curator, Division of Mammals, United States National Museum.

Two noteworthy specimens of the blue whale were collected for the National Museum in Newfoundland during the summer of 1903 by Dr. F. A. Lucas assisted by Mr. J. W. Scollick and Mr. William Palmer. Both were taken in the vicinity of Balena Station, Hermitage Bay. One is the cast of an adult female, 79 feet in length (No. 237567), obtained through the courtesy of the Cabot Steam Whaling Co. The other is the skeleton of an adult male 75 feet long (No. 49757), a gift from the Colonial Manufacturing Co. of St. Johns. They were received in Washington too late to be mentioned in Dr. F. W. True's monograph of the Whalebone Whales of the Western North Atlantic.[1] Before the skeleton was placed on exhibition in the Museum nine photographs were made by Mr. T. W. Smillie under the direction of Doctor True. None of these has yet appeared in print. Figures of the skull and other bones of *Sibbaldus musculus* are not easy to find, a fact which is particularly emphasized by their absence from the important work to which allusion has just been made. It has therefore seemed desirable to publish Mr. Smillie's remarkably fine photographs together with some measurements found among the MS. notes left by Doctor True.

Table of measurements of Sibbaldus musculus, No. 49757 U. S. National Museum.

	Measurements.	Per cent of greatest length.
Skull.		
Tip of beak to condyles (straight) ----------------meters--	5. 79	100
Greatest breadth at orbital processes of temporal-----do----	2. 74	47. 4
Diameter of foramen magnum-----------------millimeters--	110	--------
Length of rostrum-----------------------------------meters--	3. 99	68. 9
Breadth of rostrum at middle (curved)---------------do----	1. 63	28. 2
Breadth of rostrum at base (curved)-----------------do----	2. 06	35. 6
Breadth of skull at summit-------------------millimeters--	570	10. 0
Height of occipital from top of foramen magnum---meters--	1. 16	20. 0
Length of maxilla from tip to end of nasal process----do----	4. 57	78. 9
Length of maxilla from tip to end of malar process--do----	4. 20	72. 5

[1] Smithsonian Contributions to Knowledge, vol. 33. August 29, 1904.

Table of measurements of Sibbaldus musculus, No. 49757 U. S. National Museum—Continued.

	Measurements.	Per cent of greatest length.
Skull—Continued.		
Distance between condyles inferiorly ---------- millimeters--	30	--------
Distance between outer borders of condyles ---------- do----	430	--------
Distance between zygomatic and glenoid processes of temporal ---------- meters--	1. 18	20. 4
Breadth of orbital margin of frontal above ----- millimeters--	500	8. 6
Breadth of orbital process of frontal at base -------- meters--	1. 27	21. 9
Small diameter of orbit ---------- millimeters--	280	5. 0
Length of anterior border of orbital plate of frontal -- meters--	1. 19	--------
Length of posterior border of orbital plate of frontal -- do----	1. 02	--------
Length of orbital portion of jugal ---------- millimeters--	250	--------
Breadth of orbital portion of jugal ---------- do----	64	--------
Length of upper surface of nasal (straight) ---------- do----	280	5. 0
Breadth of 2 nasals anteriorly ---------- do----	250	4. 3
Breadth of 2 nasals posteriorly ---------- do----	250	4. 3
Distance between outer margins of intermaxillæ, 1.20 meters from extremity ---------- millimeters--	700	12. 0
Distance between outer margins of intermaxillæ, 2.02 meters from extremity ---------- millimeters--	690	12. 1
Distance between outer margins of intermaxillæ, 4.04 meters from extremity ---------- millimeters--	580	10. 0
Breadth of upper surface of intermaxillæ, 1.20 meters from extremity ---------- meters--	1. 23	--------
Breadth of upper surface of intermaxillæ, 2.02 meters from extremity ---------- meters--	1. 64	--------
Length of intermaxilla ---------- do----	4. 78	82. 6
Breadth of intermaxilla at middle ---------- millimeters--	320	5. 5
Greatest breadth between inner margins of intermaxillæ ---------- millimeters--	360	6. 2
Length of inferior margin of palatine ---------- meters--	1. 22	21. 1
Length of inferior margin of maxilla ---------- do----	3. 68	63. 6
Breadth of maxilla at base ---------- millimeters--	710	12. 3
Breadth of nasal process of maxilla at extremity ------ do----	150	2. 6
Distance from tip of nasal process of maxilla to tip of malar process of maxilla ---------- meters--	1. 19	20. 6
Mandible.		
Length, straight ---------- meters--	5. 68	98. 0
Length on curve ---------- do----	6. 12	105. 7
Height at symphysis ---------- millimeters--	330	--------
Height at middle ---------- do----	390	6. 8
Height at coronoid (to summit) ---------- do----	850	14. 7
Radius.		
Length along middle (without inferior epiphysis) ---- meters--	1. 02	17. 6
Breadth at proximal end ---------- millimeters--	220	--------
Breadth in middle ---------- do----	216	--------
Breadth at distal end ---------- do----	290	5. 0
Ulna.		
Length above middle (without inferior epiphysis) ---- do----	950	16. 4
Breadth at proximal end (with olecranon) ---------- do----	340	--------
Breadth at middle ---------- do----	170	--------
Breadth at distal end ---------- do----	250	4. 3
Length of insertion of olecranon cartliage ---------- do----	190	--------

Table of measurements of Sibbaldus musculus, No. 49757 U. S. National Museum—Continued.

	Measurements.	Per cent of greatest length.
Phalanges.		
Second digit:		
First phalanx .... millimeters..	230	--------
Second phalanx .... do....	180	--------
Third phalanx .... do....	100	--------
Third digit		
First phalanx .... do....	250	--------
Second phalanx .... do....	170	--------
Third phalanx .... do....	100	--------
Fourth phalanx .... do....	80	--------
Fifth phalanx .... do....	60	--------
Fourth digit:		
First phalanx .... do....	230	--------
Second phalanx .... do....	170	--------
Third phalanx .... do....	100	--------
Fourth phalanx .... do....	80	--------
Fifth phalanx .... do....	50	--------
Sixth phalanx .... do....	25	--------
Fifth digit:		
First phalanx .... do....	130	--------
Second phalanx .... do....	114	--------
Third phalanx .... do....	60	--------
Metacarpals (length).		
Second .... do....	240	--------
Third .... do....	320	--------
Fourth .... do....	250	--------
Fifth .... do....	150	--------
Sternum.		
Height .... do....	480	8. 3
Breadth .... do....	560	9. 5
Ribs.		
Length, straight:		
First .... meters..	1. 75	--------
Second .... do....	1. 78	--------
Third .... do....	2. 13	--------
Fourth .... do....	2. 24	--------
Fifth .... do....	2. 41	--------
Sixth .... do....	2. 39	--------
Seventh .... do....	2. 39	--------
Eighth .... do....	2. 29	--------
Ninth .... do....	2. 24	--------
Tenth .... do....	2. 22	--------
Eleventh .... do....	2. 15	--------
Twelfth .... do....	2. 07	--------
Thirteenth .... do....	1. 99	--------
Fourteenth .... do....	1. 89	--------
Fifteenth .... do....	1. 80	--------
Vertebrae.		
Atlas:		
Height .... mm..	480	8. 3
Breadth .... do....	490	15. 4
Axis:		
Breadth .... meters..	1. 23	21. 2
First dorsal (8), height of neural spine .... mm..	160	--------

Table of measurements of Sibbaldus musculus, No. 49757 U. S. National Museum—Continued.

	Measurements.	Per cent of greatest length.
Vertebrae—Continued.		
Axis:		
First dorsal (8), length of transverse process......mm..	420	....
First lumbar (22), neural spine..............meters..	1. 31	....
First lumbar (22), length transverse process......mm..	480	....
First caudal (36), height of neural spine.........do....	670	....
First caudal (36), length of transverse process....do....	300	....
Chevrons (*height*).		
First..........do....	90	....
Seventh..........do....	360	....
Scapula.		
Height from middle of glenoid margin..........do....	940	16. 2
Breadth, greatest..........meters..	1. 45	25. 0
Length of acromion..........mm..	480	....
Breadth of acromion at distal end..........do....	250	....
Length of coracoid..........do....	200	....
Humerus.		
Total length..........do....	580	....
Breadth at distal extremity..........do....	330	....

EXPLANATION OF PLATES.

PLATE 1.
Skull, dorsal aspect.

PLATE 2.
Skull, ventral aspect.

PLATE 3.
Skull, lateral aspect.

PLATE 4.
Atlas, anterior aspect.

PLATE 5.
Axis, anterior aspect.

PLATE 6.
Sternum, outer aspect.

PLATE 7.
Right scapula, outer aspect.

PLATE 8.
Left fore limb, inner aspect.

PLATE 9.
Pelvic elements.

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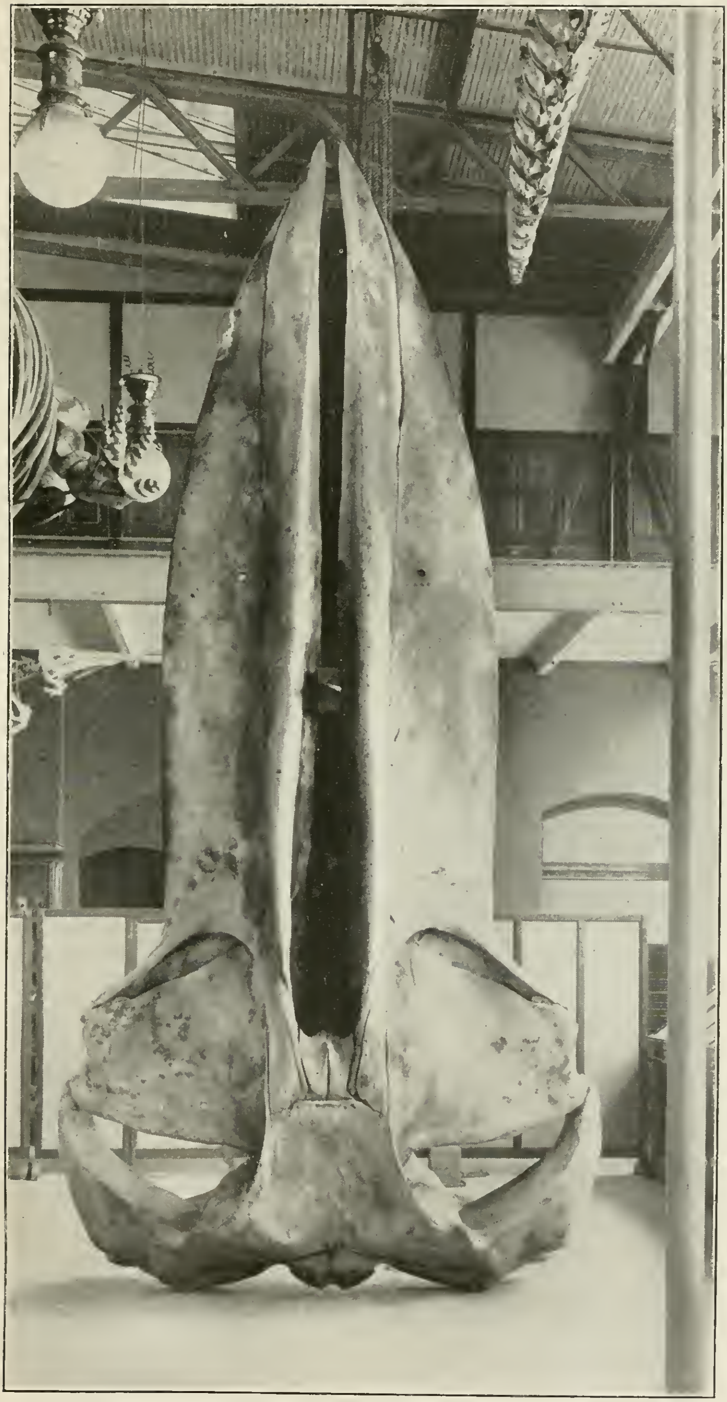
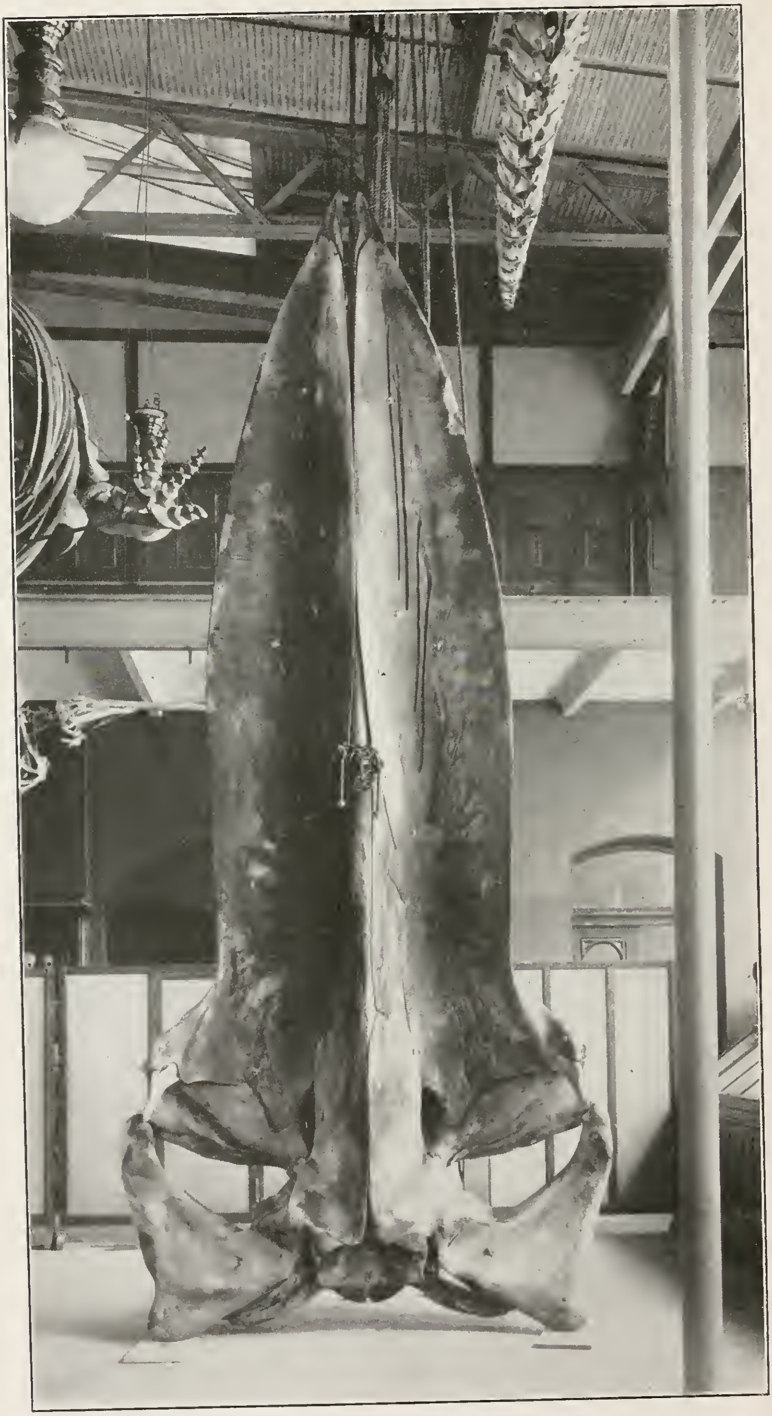


BLUE WHALE. DORSAL ASPECT OF SKULL

FOR EXPLANATION OF PLATE SEE PAGE 4



BLUE WHALE. VENTRAL ASPECT OF SKULL

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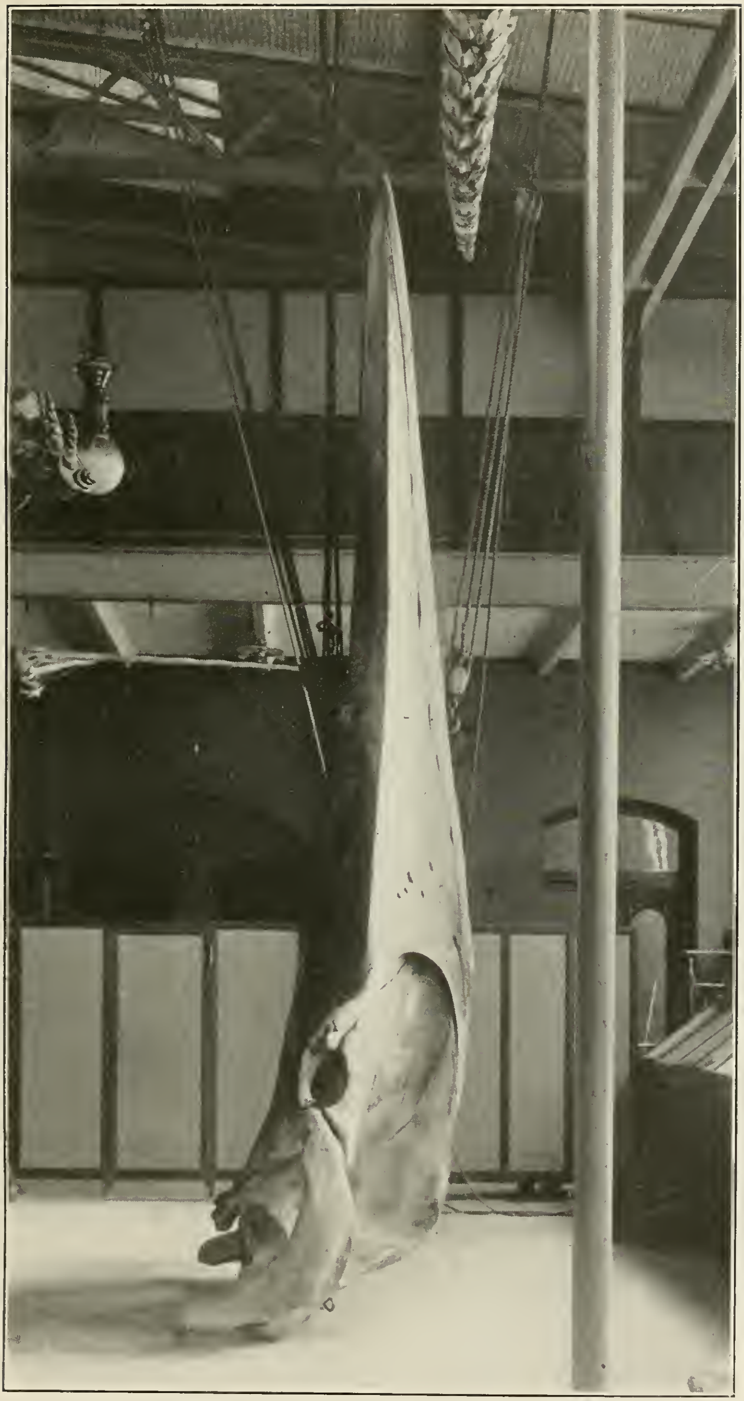
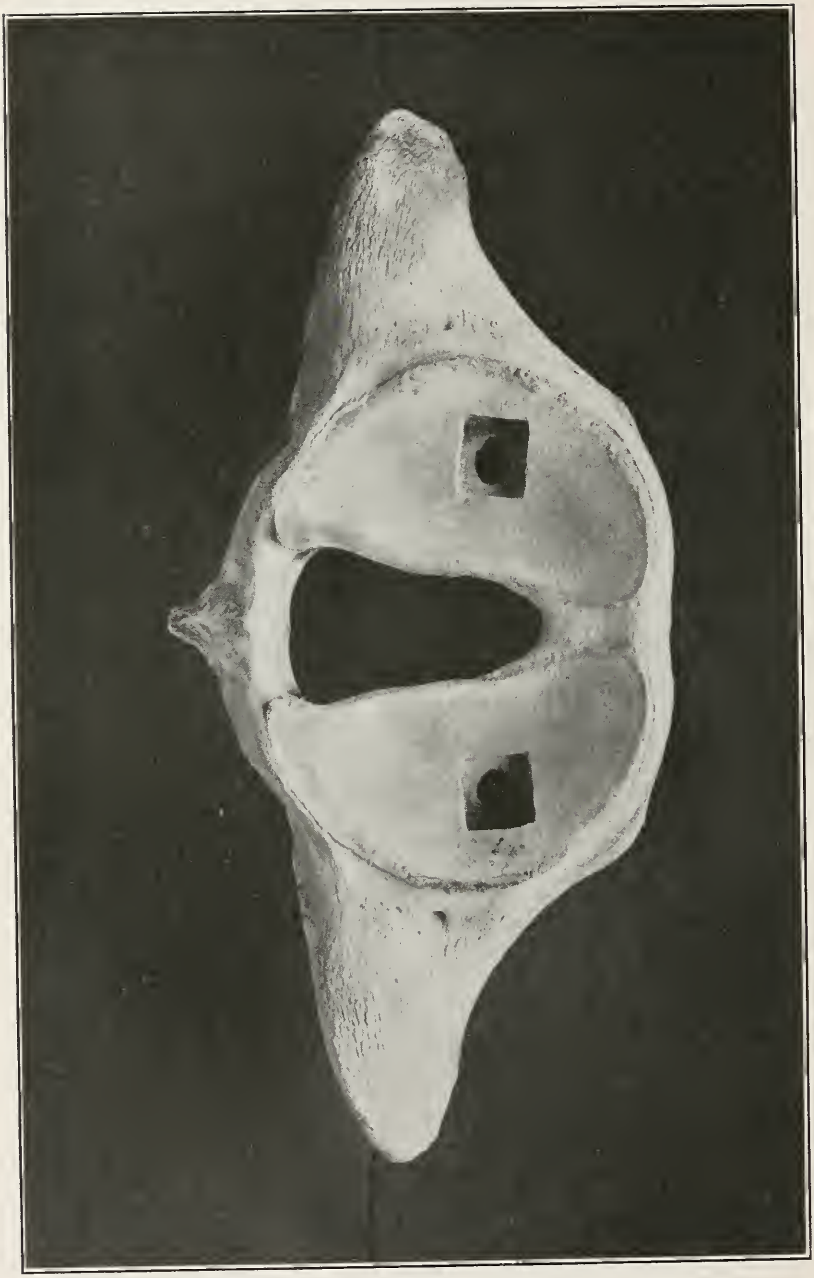


Blue Whale. Lateral Aspect of Skull

For explanation of plate see page 4



BLUE WHALE. ANTERIOR ASPECT OF ATLAS

FOR EXPLANATION OF PLATE SEE PAGE 4

BLUE WHALE. ANTERIOR ASPECT OF AXIS

FOR EXPLANATION OF PLATE SEE PAGE 4

BLUE WHALE. OUTER ASPECT OF STERNUM

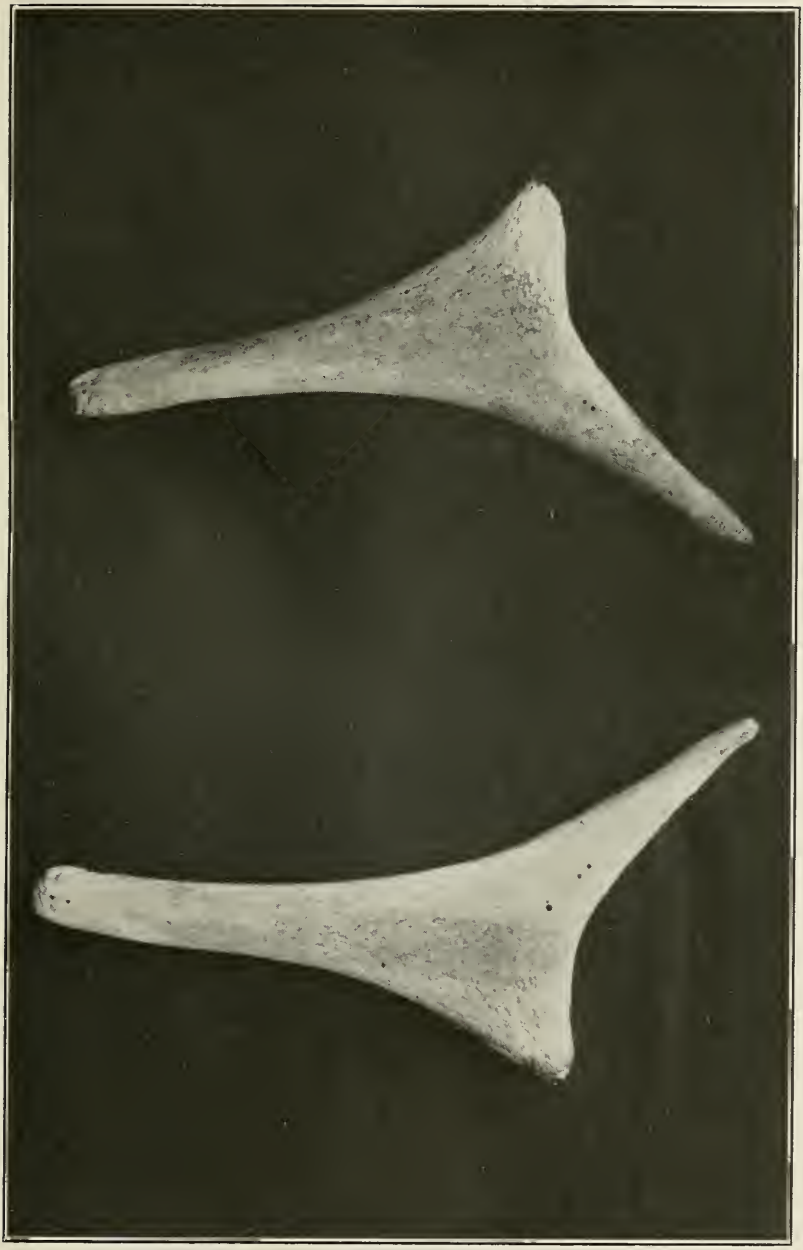
FOR EXPLANATION OF PLATE SEE PAGE 4

BLUE WHALE. OUTER ASPECT OF RIGHT SCAPULA

FOR EXPLANATION OF PLATE SEE PAGE 4

BLUE WHALE. INNER ASPECT OF LEFT FORE LIMB

FOR EXPLANATION OF PLATE SEE PAGE 4



Blue Whale. Pelvic Elements

For explanation of plate see page 4

A SECOND INSTANCE OF THE DEVELOPMENT OF RODENT-LIKE INCISORS IN AN ARTIODACTYL.

By Gerrit S. Miller, Jr.

Curator of the Division of Mammals, United States National Museum.

The rodent-like incisors of the extinct Balearic Island goat, *Myotragus balearicus* Bate,[1] have been regarded as the only instance of the development of such teeth by an even-toed ungulate. "The peculiar character of the incisors [of *Myotragus*] * * *," writes Dr. C. W. Andrews,[2] "has no parallel among the Artiodactyle ungulates, and the steps by which it has been acquired can only be surmised." Although this appears to be the generally accepted opinion on the subject, teeth whose structure nearly approaches that present in the incisors of *Myotragus* occur in a well-known living artiodactyl, the vicunia; and through the unusual conditions seen in these recent teeth the probable history of the still more specialized dentition of the fossil Balearic goat may be traced.

Photographs of incisors of *Vicugna*[3] and *Lama* are reproduced in the accompanying plate; those of *Vicugna* are at the left, and in each instance the upper three figures represent milk teeth. The characters are so very obvious that they scarcely require any detailed comment. In *Lama* the general outline of the tooth in both adult and young is strongly cuneate with the greatest width ranging from about one-fifth to about one-fourth the greatest length. The root tapers rapidly to a closed base; the enamel on the lingual side of the crown extends from the distal extremity at least one-third of the distance to the base. The milk (figs. 10–12) and permanent (figs.

[1] Geol. Magazine, ser. 5, vol. 6, p. 385. September, 1909.

[2] A description of the Skull and Skeleton of a Peculiarly Modified Rupicaprine Antelope (*Myotragus balearicus*, Bate), with a notice of a New Variety, *M. belearicus* var. *major*. Philos. Trans. Roy. Soc. London, ser. B, vol. 206, pp. 281–305, pls. 19–22. June 30, 1915.

[3] Gray, Cat. Rum. Mamm. Brit. Mus., p. 101, 1872, type *Camelus vicugna* Molina. Under the provisions of the International Code the availability of this name does not appear to be interfered with by the existence of the earlier *Vicunia* Rafinesque (Analyse de la Nature, p. 55, 1814), proposed as a substitute for *Lama* Cuvier. The peculiarities of the incisors are so great that I would separate the vicunia generically from the llama and guanaco.

13–15) teeth are therefore essentially alike in form and structure. In *Vicugna* the permanent teeth (figs. 5–9) are strikingly different from their predecessors (figs. 1–3). The milk teeth are more elongate than those of either adult or young *Lama* (greatest breadth about one-sixth or less of the greatest length), but their form is still obviously cuneate: the bases, however, remain open, and there is no enamel on the lingual side of the crown. The enamel of the labial side occupies slightly more than half the length of the tooth, a condition intermediate between that which is seen to occur in the milk and permanent teeth of *Lama*. The adult teeth of *Vicugna* have lost all trace of the cuneate form. They are parallel-sided, fully ten times as long as wide, armed with a rodent-like plate of enamel confined to the lingual aspect of the tooth and extending to within 2 or 3 millimeters of the widely open base. Apparently these teeth continue to grow through most of the animal's life; but in extreme senility (in a captive individual at least) growth may cease and the teeth may become completely worn down to stubs (fig. 4).

Comparison of the figures here published with Figure 8 of Doctor Andrews's Plate 20 will show the striking likeness which exists between the teeth of *Vicugna* and *Myotragus*. Aparently it is not definitely known whether the incisors of the goat were truly ever-growing as they are in rodents or whether they exhibit the same conditions with regard to maner of growth as those found in the vicunia. Assuming that they were strictly rodent-like in this respect they would represent a stage of development a step farther advanced than that exemplified by the adult incisors of *Vicugna*. The transitional conditions leading back from the structure present in the adult vicunia to the one normal to the incisors of artiodactyls in general may be seen in the vicunia's milk teeth. Here the original cuneate form has become elongated, the base of the root has been permanently opened, and the enamel has been eliminated from the lingual aspect of the crown. While the morphological elements of the problem of the development of rodent-like incisors in artiodactyls therefore no longer present any special obscurities the physiological impulse which may have initiated the change of form in the teeth of both the vicunia and the Balearic goat appears to be still entirely unknown.

EXPLANATION OF PLATE.

Incisor teeth of Vicunia and Guanaco. All figures slightly reduced.

Vicugna vicugna.

FIG. 1. No. 38451. Milk dentition, i_2 left, lingual surface.
2. No. 38451. Milk dentition, i_1 left, lateral surface.
3. No. 38451. Milk dentition, i_1 right, labial surface.
4. No. 199253. Completely worn out stubs of i_1, right and i_1 left, in senile captive individual.
5. No. 194297. Permanent dentition, i_2 left, lingual surface.

FIG. 6. No. 194297. Permanent dentition, i_2 right, split longitudinally to show pulp cavity.
7. No. 194297. Permanent dentition, i_1 left.
8. No. 96611. Permanent dentition, i_1 right, split longitudinally to show pulp cavity. (A younger individual than No. 194297.)
9. No. 194297. Permanent dentition, i_1 right, labial surface.

Lama huanachus.

FIG. 10. No. 194291. Milk dentition, i_2 left, lingual surface.
11. No. 194291. Milk dentition, i_1 left, lateral surface.
12. No. 194291. Milk dentition, i_1 right, labial surface.
13. No. 194294. Permanent dentition, i_2 left, lingual surface.
14. No. 194294. Permanent dentition, i_1 right, lateral surface.
15. No. 194294. Permanent dentition, i_1 left, labial surface.

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1 10

2 11

3 12

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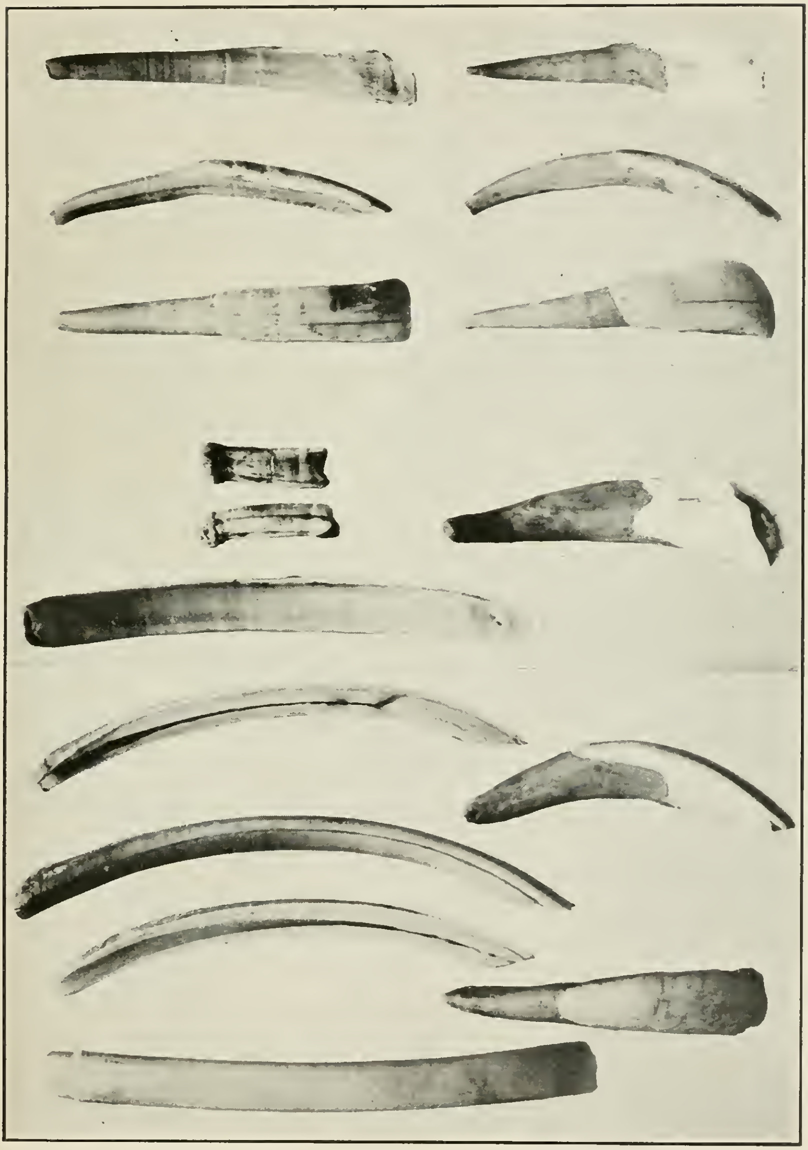

INCISOR TEETH OF VICUNIA (1–9) AND GUANACO (10–15)

FOR EXPLANATION OF PLATE SEE PAGES 3–4

A POLLACK WHALE FROM FLORIDA PRESENTED TO THE NATIONAL MUSEUM BY THE MIAMI AQUARIUM ASSOCIATION.

By Gerrit S. Miller, Jr.

Curator, Division of Mammals, United States National Museum.

Among the whalebone whales found on the Atlantic coast of North America the Pollack Whale (*Balænoptera borealis*) is the species about whose occurrence the least is known. Hitherto the only recorded eastern American specimens have been some blades of baleen from Newfoundland, in the Brooklyn Institute of Arts and Sciences, and one jaw, several blades of baleen, and two ribs from Chatham Light, Massachusetts, in the Museum of the Boston Society of Natural History. The species was omitted from the main text of Dr. F. W. True's elaborate paper on "The Whalebone Whales of the Western North Atlantic;"[1] and in Dr. Glover M. Allen's "Whalebone Whales of New England"[2] the description of it was chiefly based on the published accounts of specimens from Europe and Japan.

The generosity of the Miami Aquarium Association has now made it possible to examine the complete skeleton of an American Pollack Whale. This individual, an adult male (No. 236680, U. S. National Museum), was cast ashore at Pablo Beach, about 18 miles east of Jacksonville, Duval County, Florida, in May, 1919. The skeleton was prepared, according to directions sent from the United States National Museum, by Mr. R. J. Wallace, of Jacksonville, who, after exhibiting it during several months, finally offered it for sale. It was then purchased by the Aquarium Association through the special interest of Mr. James Asbury Allison, president, and Mr. John Oliver La Gorce, treasurer, and presented to the United States National Museum in September, 1920.

Good general accounts of the habits and distribution of the Pollack Whale are readily accessible in the paper by Dr. G. M. Allen cited above, and in Mr. Roy C. Andrews's "The Sei Whale

[1] Smithsonian Contributions to Knowledge, vol. 33. August 29, 1904.
[2] Mem. Boston Soc. Nat. Hist., vol. 8, No. 2. 1916.

(*Balænoptera borealis* Lesson)," (Monographs of the Pacific Cetacea, II).[3] These authors have so fully covered this part of the subject that it seems unnecessary to repeat the details in the present connection, especially as I have no new observations to record. The Pollack Whale was first described in 1822 from an individual cast up three years before at Grömitz, on the Baltic coast of the Province of Holstein, Germany. Since then it has become rather well known as a summer visitant to the coastal waters of the North Sea, where it is frequently taken at whaling stations in Norway, Ireland, and Iceland. The fact of its occurrence in the western North Atlantic was not established until the publication of a note by True in 1903,[4] recording the capture of four individuals in Placentia Bay, Newfoundland, during the previous summer. It is now known to frequent the Newfoundland coast regularly in small numbers. One was stranded at Chatham, Massachusetts in August, 1910, and this specimen, represented, unfortunately, by nothing more than a photograph and a few pieces of baleen and bone, is the only one hitherto recorded from the coast of the United States. While the range of the true Pollack Whale is centered in the North Atlantic, that of the group to which the animal belongs has recently been found to be much more extensive, embracing the South Atlantic,[5] the Antarctic Ocean,[6] the Indian Ocean, and the North Pacific. (See the paper by Andrews already referred to.) Whether the one species *Balænoptera borealis* occurs throughout this area or whether there are two or more nearly related local forms are questions which can not now be answered. Probably they must remain unanswered until a sufficient number of skulls from some one locality can be studied to give a definite idea of the limits of individual variation. In habits the Pollack Whale does not appear to differ conspicuously from the other finbacks. It undoubtedly moves about extensively as the seasonal food supply changes, and it may perform regular migrations; but accurate data on these subjects are at present lacking. The bristles of its baleen are fine in texture, and this may indicate that unusually much of its food consists of pelagic crustaceans. It is known, however, to feed occasionally on small fish.

I have prepared the following account of the Jacksonville specimen somewhat in the form of a supplement to Dr. F. W. True's monograph of the whalebone whales of the North Atlantic, adopting so far as possible the plan of arrangement and treatment followed in this well-known work.

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[3] Mem. Amer. Mus. Nat. Hist., n. s., vol. 1 pt. 4, pp. 291–460, pls. 29–42. 1916.

[4] Science, n. s., vol. 17, p. 150. January 23, 1903.

[5] Saldanha Bay, near Capetown; Olsen, Bergens Museums Aarbog, No. 5, p. 52. 1915.

[6] Liouville, Deuxième Expéd. Ant. Française, Cétacés, pp. 100–110. 1913.

COMPARISON OF THE POLLACK WHALE WITH THE BETTER-KNOWN NORTH AMERICAN FINBACKS.

Good photographs of the fresh specimen were not obtained at Pablo Beach, and no detailed measurements were taken. The length of the animal is said to have been 45 feet. Nothing can therefore be added to that which was previously known of the external characters. From the various published accounts it appears that stranded individuals of the Pollack Whale may be distinguished among the American finbacks by the following peculiarities.

(1) Size moderate (total length usually ranging from 35 to 50 feet), greater than in the Pike Whale (usually less than 30 feet), less than in the Common Finback (usually 55 to 75 feet), and the Blue Whale (usually 60 to 90 feet).

(2) Whalebone plates (pl. 20, fig. 2) uniformly blackish horn color, the extremely fine and hair-like bristles a very pale horn color appearing conspicuously whitish by contrast, and therefore usually described as " white " (plates and coarse bristles all pale horn color in the Pike Whale, all blackish horn color in the Blue Whale, some dark, some light, in the Common Finback).

(3) Folds on the throat in region between the flippers about 40 to 60, as in the Pike Whale, not about 60 to 80 as in the large Common Finback and Blue Whale.

(4) Flippers uniformly dark colored, as in the Common Finback and Blue Whale, not conspicuously pied as in the Pike Whale.

(5) Dorsal fin relatively high, as in the Pike Whale (its height equal to about one-third depth of body measured at base of fin; in the Common Finback and Blue Whale it is equal to only about one-fifth or one-sixth the depth of body in same region).

The structure of the skeleton in the Pollack Whale shows many pecularities as compared with that in the other American finbacks.

Skull (pls. 1–4).—The skull has the general form seen in the Pike Whale and the Common Finback—that is, the rostrum when viewed from above or below is triangular in outline, with lateral margins essentially straight or faintly curved from base to tip. It therefore differs conspicuously from the skull of the Blue Whale, in which the rostrum is not triangular, its sides being parallel, or nearly so, from the base almost to the middle, then rather strongly curved to the tip, the curve of each side following approximately the arc of a circle whose radius is about as long as the intermaxillary bone. Further comparison with the Blue Whale is scarcely necessary, as this animal is so different from the other finbacks that I do not regard it as a member of the genus *Balænoptera*. It may be mentioned, however, that in the Pollack Whale the nasals are relatively larger than in the Blue Whale (their length is contained about 9½

times instead of about 15 to 20 times in length of intermaxillary and about $6\frac{1}{4}$ times instead of 8 to 11 times in interorbital breadth); the intermaxillaries decrease gradually in breadth beyond middle; the palatines leave a considerable portion of the basisphenoid exposed when the skull is viewed from below; the malar bone is relatively larger (in somewhat the same proportion as the nasal); the articular part of the squamosal is, in lateral view, much deeper in proportion to its length; the coronoid process of the mandible is low and triangular instead of high and irregular in outline; and the groove marking the limit between the angular and articular portions of the mandible is better developed, particularly on the inner side.

When contrasted with skulls of the Pike Whale and the Common Finback of eastern North America, that of the Pollack Whale is distinguishable by (*a*) the greater relative length of the rostrum with regard to the rest of the skull as well as by the narrowness and shallowness of the rostrum as compared with its own length (the length of the rostrum, measured in photographs, from anterior border of posterior maxillary concavity to tip is equal to slightly more than twice distance in median line from level of maxillary concavity to back of occipital condyles, while in both the other species it equals decidedly less than twice this distance; the greatest width of the rostrum immediately in front of region where the maxillary border turns abruptly outward is equal to less than half the distance from this widest region to anterior extremity of maxillary, while in both the other species it is equal to more than half this distance; the depth of the rostrum at anterior margin of posterior maxillary concavity is contained a little more than five times instead of about four times in distance from anterior margin of maxillary concavity to tip); (*b*) the low, broadly triangular instead of irregularly short ligulate form of the coronoid process of the mandible (compare pl. 3, figs. 2 and 3, with True's pl. 3, fig. 3, and pl. 27, fig. 2.); (*c*) the extension of the palatine bones so far backward that the portion of the basicranial region exposed behind them (when skull is viewed from below) is squarish in outline instead of longer than broad; (*d*) the presence on the supraorbital portion of the frontal of a noticeable oblique ridge extending outward and backward from region of middle of posterior maxillary concavity to region of middle of orbit (this ridge is present in the two skulls of the Pollack whale examined, one from Florida, the other from Japan; it is absent in the four skulls of the Common Finback figured by True, and in a fifth skull, No. 237566, received from Newfoundland in 1904; it is also absent in the four skulls of the Pike Whale figured by True); (*e*) the conspicuously greater depth and robustness of the articular por-

tion of the squamosal and the less concave lower border and less evenly crescentic form of this bone when viewed from the side (posterior limb of crescent much wider (deeper) than anterior limb); (*f*) the unusually deep and narrow sulcus formed at the region of juncture between the squamous and articular portions of the squamosal (see pl. 4, *sq. sulc.;* also compare pl. 2 with True's pl. 2, *B. physalus*, pl. 24, *B. acutorostrata*, pl. 30, *Megaptera*, and pl. 47, *Rhachianectes*); and (*g*) the depth, particularly on the inner side, of the groove lying between the articular and angular portions of the mandible.

In addition to these characters which distinguish it from the skulls of both the Common Finback and the Pike Whale the skull of the Pollack Whale may be recognized as follows:

As compared with the Common Finback (see pls. 1, 2, and 3, also pls. 41 and 42 of Andrews's monograph; compare with pls. 1–4 of True's Whalebone Whales of the North Atlantic): Nasal bones (*a*) much larger, their anterior border extending forward about to level of anterior border of posterior maxillary concavity instead of falling conspicuously short of this level, (*b*) their anterior margin nearly straight instead of deeply concave, (*c*) the greatest combined width of the two bones much less than length of median suture instead of about equal to median suture; nasal process of maxillary conspicuously broader, its least width contained about two and one-half times instead of about five times in its length.

As compared with the Pike Whale (compare with pls. 22–27 of True's Whalebone Whales): Extreme of contrast between size of rostrum as compared with rest of skull; less relative width of intermaxillary gutter immediately in front of nasals; auditory bulla relatively smaller (its length about one-third width of basioccipital); jugal relatively shorter (its length contained about two and one-half times instead of about one and one-half times in length of outer portion of articular process of squamosal).

Vertebræ (pls. 5–15).—The vertebral formula is C. 7, D. 14, L. 13, Ca. 19 (+4?) = 57. The boundary between lumbars and caudals is not certain. There appear to be four caudals lacking at the distal extremity of the series. Last vertebra with neural spine, No. 46; last with distinct tranverse process, No. 43 (vanishing traces on Nos. 44–46); first with perforated transverse process, No. 38.

In its general features the vertebral column is characterized by the height and erectness of the spinous processes, peculiarities that are most noticeable at the middle of the series. In the last dorsal and first seven lumbars the length of the spinous process equals about three times the depth of the centrum, while in the Common Finback from Maryland figured by True (pl. 5) the processes are barely twice as high as the centra. In the skeleton from Danzig, Germany, figured

by Menge,[7] they are even shorter, little more than one and one-half times the depth of the centra. In the Pike Whale, however (see True, pl. 27, fig. 2), the relative height of the spinous processes is essentially as in the Pollack Whale. With regard to the backward slant of the spinous processes the Pollack Whale differs from both the Common Finback and the Pike Whale. In the two better-known animals the processes rake backward to such a degree that in the median portion of the series the entire upper margin of the process is frequently carried back beyond the level of the posterior margin of the centrum. (See figures by True and Menge already referred to. This character is readily observed in a mounted skeleton of the Common Finback from Cape Cod, U.S.N.M. No. 16045. It is even more pronounced in a skeleton of the Blue Whale from Newfoundland, No. 49757.) The spinous processes in both the Florida skeleton and the Japanese specimen (Andrews, figs. 18–20) are, on the other hand, so little inclined backward that in no vertebra of either individual does the antero-upper angle of the process attain the level of the posterior articular surface of the centrum. A near approach to this condition may be seen in some of the Japanese vertebræ, notably lumbars 3 and 8, but all the vertebræ in this individual appear to lack the epiphyses, thus making the backward extension of the centra less than normal. The more detailed features of the vertebræ are shown by the photographs reproduced in the plates

Ribs (pl. 16).—The bifid head of the first rib, a character nearly always present in the Pollack Whale, is clearly shown by the Florida specimen. In another peculiarity the ribs differ from those of the mounted skeletons of the Common Finback (No. 16045) and Blue Whale (No. 49757) in the National Museum: The combined neck and head form a large and conspicuous process in the second, third, and fourth ribs of the two better-known finbacks, projecting inward toward the centra beyond the tubercle; this projection is a mere irregular knob on the second and fourth [8] rib of the Pollack Whale, fairly well developed, though short, on the third only. This is probably a specific character, as the devolpment of the combined neck and head is essentially alike in both of the skeletons of the better known species, though the Blue Whale is fully adult, while the Common Finback is an immature individual with the epiphyses of the vertebræ not fused to the centra. In the skeleton of the Pike Whale (No. 20931). however, a third condition is represented: The collum is present and distinct but short on the second rib, very rudimentary on the third, and absent from the fourth. It is possible that the

[7] Schr. naturforsch. Gesellsch. Danzig, vol. 3, pt. 4. 1875.
[8] Too large as restored, judging by the structure of the left rib.

slight development of the collum in this specimen and in the Pollack Whale from Florida may in each case be an individual peculiarity; that immaturity does not account for it is shown by the fact that both skeletons came from aged individuals with the epiphyses of the vertebræ so completely fused that they are scarcely distinguishable. The separated ribs of the Common Finback shown by True (pl. 6, fig. 1) are from an animal too young to have developed the characters in question; the same is the case with those of the Pollack Whale figured by Andrews. In the mounted skeleton of a Common Finback from California, photographs of which are reproduced by True as text figures 95 and figure 4 of plate 6, the long collum of ribs 2, 3, and 4 may, however, be distinctly seen, especially in figure 95.

Chevron bones.—The chevron bones were all lost before the skeleton was received in Washington.

Sternum (pl. 18, fig. 1).—The outline of the sternum differs from that in all of the 25 sterna of the Common Finback figured by True on pages 140 and 141 and of the 10 of the Pike Whale on page 205. The portion of the cross which lies in front of the transverse arms is relatively larger than in any of those of the two better-known species; the length of the posterior median projection, in proportion to the width of the sternum, is about the same as the average for the Common Finback, but is less than in any of the sterna of the Pike Whale.

Scapula (pl. 17).—As compared with the scapula of the other American finbacks, so far as can be judged from very inadequate material, that of the Pollack Whale is distinguishable by greater width in proportion to the height and by the length, distinctness, and narrowness of the neck. The least width of the neck above the base of the coracoid process is contained a little more than four times in the greatest width of the blade, while in the other Atlantic finbacks it appears to be usually contained about three and one-half times. The acromion process is long and slender, with parallel sides, as in the Pike Whale, and without the tendency to broaden toward the tip, which is seen in the acromion of the Common Finback and the Blue Whale. The coracoid process is more slender than appears to be usually the case with that of the two larger finbacks; it thus agrees with the coracoid of the Pike Whale.

Bones of the arm and hand (pl. 19).—The bones of the arm are characterized by length and slenderness, features which are particularly noticeable in the humerus and radius. Apart from this general feature, which appears to distinguish the arm from that of all the other finbacks, I do not detect any peculiarities worthy of special note.

The metacarpals and such phalanges as are preserved agree in general form with those of the Common Finback and the Pike

Whale—that is, they are decidedly more constricted at middle in proportion to their length than in the Blue Whale.

Pelvic rudiments.—No pelvic rudiments were preserved.

Hyoid bones (pl. 18, figs. 2 and 3).—Though the material for comparison is not sufficient to give positive results, it indicates that the hyoid bones of the Pollack Whale differ noticeably from those of the other finbacks in the great depth of the concavity on the dorsal side of the combined basihyal and thyrohyals (fig. 3). In the Florida specimen the depth of this concavity is 225 mm. and the distance between the inner margins of the tips of the thyrohyals is 685 mm. The depth of the concavity is therefore 32.8 per cent of the width. In a hyoid of the Blue Whale from Newfoundland (No. 237567) the same measurements are, respectively, 275 and 1310. Here the depth of the concavity is only 20.9 per cent of the width. Yet the hyoids of this Blue Whale and of the mounted specimen (No. 49757) appear to be distinctly more concave than in the mounted specimens of the Common Finback (No. 16045) and Pike Whale (No. 20931). The thyrohyals in the Pollack Whale are much longer relatively to the central mass of the bone than in the Pike Whale, and they are not expanded at the middle as in the two specimens of the Blue Whale. The photograph does not give a proper idea of the size and length of the thyrohyals in the Florida specimen. It shows the bone from the ventral side with the thyrohyals curving away from the camera and consequently much reduced in apparent size as compared with the central portion of the bony mass. The same is true of the figure published by Andrews (fig. 13, p. 356). I can see no important features in the stylohyal (fig. 2).

Tympanic and periotic bones (pl. 22).—The smaller auditory bones have been lost. Probably they were jarred out of place during the period when the skeleton was being carried about the country on a truck. The tympanic and periotic of the left side are shown in several aspects on plate 22. Material for comparison with the ear bones of other finbacks is not very satisfactory, owing to the absence of fully authenticated specimens of *Sibbaldus*, but there appear to be rather well-marked characters by which the various Atlantic species of baleen whales can be identified on the basis of the periotic bone.

The periotic of *Eubalæna* (family *Balænidæ*) is immediately distinguishable from that of the finbacks and humpback (family *Balænopteridæ*) by the relative positions of the anterior and posterior petrous processes. The anterior process in *Eubalæna* is drawn inward toward the posterior process, so that the axes of the two processes converge at an angle which is decidedly less than a right angle instead of somewhat greater than a right angle as in the finbacks and humpback. Apparently this difference is due almost entirely

to alterations in the position of the anterior process, since the relationship of the posterior process to the cochlear mass is essentially identical in the two types of periotic. The anterior process, however, is so placed in the right whale that its axis is about parallel to a prolongation of that of the internal acoustic meatus, while in the finbacks and humpback its axis forms at least a right angle with the prolonged axis of the meatus. Another peculiarity of the periotic in the right whale is the relatively small size of the cochlear mass, a character which is not readily described, but which is immediately apparent on comparison of the periotic of a right whale with that of the humpback or of any of the finbacks.

Among the *Balænopteridæ* the genus *Megaptera* appears to be distinguished by a conspicuous tendency toward heightening the cochlear portion of the periotic, so that the orifices appear to stand at the base or on the side of a nearly perpendicular wall, while in the finbacks they are situated on an oblique or nearly horizontal surface. In *Balænoptera physalus* the orifices of the internal acoustic meatus and the facial canal are separated from each other by a mass of bone whose diameter is fully as great as that of the canal, a peculiarity which appears to be diagnostic of the species. The opposite condition is seen in *Balænoptera acutorostrata*, in which the two orifices lie at the bottom of a common pit or tube with no definite septum between them. A well-developed but narrow septum is found in *Balænoptera borealis* and *Sibbaldus musculus*, but the periotic bones of these two animals are readily distinguished by the different development of the fossa for the stapedial muscle, this fossa having a very narrow, contracted area in *B. borealis*, while in *Sibbaldus* it is of the normal widely spread type.

The material examined (representing four individuals of *Eubalæna*, two of *Megaptera*, three of *Balænoptera physalus*, two of *B. acutorostrata*, one of *B. borealis*, and two supposedly *Sibbaldus*) is not sufficiently extensive to form the basis of any generalizations as to the true value of all the characters which I have mentioned, but it appears to be reasonably probable that most of these peculiarities represent features which are constant. Assuming that they have a definitely taxonomic value, the characters of the ear bones in the baleen whales of the North Atlantic may be arranged as follows:

Axis of anterior petrous process approximately parallel with axis of internal acoustic meatus; axes of anterior and posterior petrous processes converging at an angle much less than a right angle; auditory region proper relatively small; tympanic squarish or irregularly rhomboidal in outline____**Balænidæ.**

Axis of anterier petrous process approximately at right angles with axis of internal acoustic meatus; axes of anterior and posterior petrous processes converging at an angle obviously greater than a right angle; auditory region proper relatively large; tympanic ovate in outline__________**Balænopteridæ.**

Auditory region conspicuously elevated; orifices situated on the side or at the base of a nearly perpendicular wall**Megaptera nodosa.**

Auditory region not conspicuously elevated; orifices situated on an oblique or nearly horizontal area.

Internal acoustic meatus separated from cerebral orifice of facial canal by a bony septum about as wide as the orifice of the canal **Balænoptera physalus.**

Internal acoustic meatus not separated from cerebral orifice of facial canal by a broad bony septum.

Cerebral orifice of facial canal and internal acoustic meatus opening together at bottom of deep common pit **Balænoptera acutorostrata.**

Cerebral orifice of facial canal and internal acoustic meatus separated by a narrow, high, bony septum.

Fossa for stapedial muscle small, its greatest width less than half that of cochlear region**Balænoptera borealis.**

Fossa for stapedial muscle large, its greatest width more than half that of cochlear region**Sibbaldus musculus.**

COMPARISON OF THE FLORIDA SPECIMEN WITH THE JAPANESE SKELETON IN THE AMERICAN MUSEUM OF NATURAL HISTORY.

Through the kindness of the authorities of the American Museum of Natural History I have been enabled to examine the Japanese skeleton of *Balænoptera borealis* collected by Mr. Andrews and to bring some of the smaller bones to Washington for direct comparison with our specimen. The two individuals shows numerous points of difference in structure. In our present state of ignorance on the subject of variation in the baleen whales I shall not, however, try to draw any conclusions as to the meaning of these differences.

Comparison of plates 1, 2, and 3 with Mr. Andrews's plates 41 and 42 will show the principal features of difference between the two skulls. In dorsal view these are to be found in the shape of the occipital shield, in the relative length and breadth of the nasal and of the nasal process of the intermaxillary, in the outline of the orbital wing of the frontal and the apparently greater area of the wing in the Japanese specimen as compared with that of the occipital shield, and in the conspicuous swelling outward in the Florida specimen of the upper part of the parietal and squamous portion of the squamosal beyond the edge of the dorsal shield. The less swollen condition of the squamous portion of the squamosal in the Japanese specimen is further indicated by the photographs reproduced in plate 4 showing an oblique view into the temporal fossa. In lateral view the rostrum appears to be deeper in proportion to its length and less curved in the Japanese specimen. The articular portion of the squamosal is also deeper in proportion to its length. How far these peculiarities may result from the slight difference of orientation in the two photographs I am unable to say, but I do not believe that they are all due to this cause. In ventral view the longer narrower

palatine and the more robust articular portion of the squamosal of the Japanese specimen are conspicuous features. A character which may be more important is seen in the different backward projection of the exoccipitals and the postero-external angle of the squamosal behind the level of the occipital condyles. This backward projection is slight in the photograph of the skull from Florida, conspicuous in the one from Japan. Apparently the orientation is nearly the same in the two photographs, but the difficulty of making an exact comparison of such a character between two skulls of such large size, one of which is in New York and the other in Washington, is so great that not much reliance can be placed on the peculiarities which appear to exist.

In the cervical vertebræ there are many features of difference between the two specimens. These can be best understood by comparing my plates 5 to 8 with Mr. Andrews's text figures 14 to 17. In general they consist principally in the greater width relatively to the height in the Japanese specimen and in differences in the angle of outward projection of the processes when viewed from the side. In reckoning the height the spinous process is not to be included, as this is uniformly low in the relatively immature Japanese skeleton. The differences, as will at once be seen, are conspicuous, extending even to the shape of the centra; but it is impossible to say how far they are due to the considerable disparity in the age of the two animals, or to possible specific features which may eventually be found to distinguish the representatives of *Balænoptera borealis* in the two oceans. In comparing the figures of the other vertebræ, my plates 12 to 15, Andrews's text figures 18 to 28, the fact must be kept in mind that the centra of the Japanese specimen lack the epiphyses.

Other peculiarities will be seen on comparing the figures of the scapula, the limb bones, and the jugal. The jugal of the Japanese specimen (pl. 19, fig. 2) is remarkable for its robustness as compared with that of the much older individual from Florida (pl. 19, fig. 1).

MEASUREMENTS.

Length of skull (straight), 3 m. 480 mm.
Greatest breadth (squamosal), 1 m. 600 mm.
Breadth of orbital wing of frontal at distal end, 390 mm.
Length of maxillary along upper surface, 2 m. 550 mm.
Length of intermaxillary along upper surface, 2 m. 690 mm.
Breadth of beak at middle (curved) 670 mm.
Length of nasal, 260 mm.
Breadth of exposed portion of two nasals at distal end, 135 mm.
Breadth of exposed portion of two nasals at proximal end, 90 mm.
Length of mandible (straight), 3 m. 290 mm.
Length of mandible (curved), 3 m. 415 mm.
Depth of mandible at middle, 275 mm.
Depth of mandible through coronoid process, 370 mm.

Greatest breadth of axis, 680 mm.
Depth of body of axis, 155 mm.
Greatest breadth of fourth cervical, 668 mm.
Height of fourth cervical from lower border of centrum, 320 mm.
Greatest breadth of fifth cervical, 608 mm.
Height of fifth cervical from lower border of centrum, 295 mm.
Greatest breadth of sixth cervical, 570 mm.
Height of sixth cervical from lower border of centrum, 365 mm.
Greatest breadth of seventh cervical, 572 mm.
Height of seventh cervical from lower border of centrum, 420 mm.
Greatest breadth of first dorsal, 630 mm.
Height of first dorsal from lower border of centrum, 430 mm.
Centrum of first dorsal: Width, 215 mm.; depth, 160 mm.; length, 75 mm.
Greatest breadth of seventh dorsal, 770 mm.
Centrum of seventh dorsal: Width, 215 mm.; depth, 155 mm.; length, 175 mm.
Greatest breadth of first lumbar, 915 mm.±
Centrum of first lumbar: Width, 325 mm.; depth, 175 mm.; length, 210 mm.
Greatest breadth of first caudal, 640 mm.
Centrum of first caudal: Width, 265 mm.; depth, 220 mm.; length, 260 mm.
Greatest length of sternum, 320 mm.
Greatest breadth of sternum, 285 mm.
Greatest breadth of scapula, 1 m. 50 mm.
Greatest depth of scapula, 590 mm.
Length of humerus, 350 mm.
Greatest width of humerus (proximal), 215 mm.
Greatest width of humerus (distal), 190 mm.
Greatest width of humerus (median), 145 mm.
Length of radius, 710 mm.
Length of ulna (outer side), 700 mm.
Length of ulna (inner side), 635 mm.
Combined width of radius and ulna (proximal), 310 mm.
Combined width of radius and ulna (distal), 240 mm.
Combined width of radius and ulna (median), 180 mm.
Length (median) of first right metacarpal, 115 mm.
Length (median) of second left metacarpal, 140 mm.
Length (median) of third left metacarpal, 133 mm.
Length (median) of fourth left metacarpal, 107 mm.
Length (median) of first phalanx, first right digit, 115 mm.
Length (median) of first phalanx, second right digit, 132 mm.
Length (median) of second phalanx, second right digit, 122 mm.
Length of first rib (greatest in straight line), 925 mm.
Greatest diameter of first rib, 270 mm.
Section of first rib at middle, 124 by 36 mm.
Length of seventh rib (greatest in straight line), 1 m. 640 mm.
Length of seventh rib (following curve), 2 m. 45 mm.
Length of stylohyal (greatest in straight line), 445 mm.
Length of basihyal, 265 mm.
Width of basihyal (greatest in straight line), 750 mm.
Width of basihyal (following curve), 910 mm.
Length of lacrimal, 265 mm.
Greatest width of lacrimal, 113 mm.
Length of jugal (greatest in straight line), 325 mm.
Largest baleen plates, 640 mm.

Greatest diameter of auditory bulla, 223 mm.
Distance from stapes to tip of anterior petrous process, 173 mm.
Distance from stapes to tip of posterior petrous process, 360 mm.

EXPLANATION OF PLATES.

Skeleton of *Balænoptera borealis*.

PLATE 1.

Skull from above.

PLATE 2.

Skull from below.

PLATE 3.

Skull from the side.

FIG. 1. Skull from right side.
2. Left mandible from outer side.
3. Left mandible from inner side.
4. Left mandible from above.

PLATE 4.

Oblique view of braincase.

FIG. 1. No. 236680 U. S. Nat. Mus. (Florida).
2. No. 34871 Amer. Mus. Nat. Hist. (Japan).

fr. frontal.
i. intermaxillary.
ip. interparietal.
mx. maxillary.
n. nasal.
occ. occipital.
p. parietal.
sq. squamosal.
sq. sulc. squamosal sulcus.

PLATE 5.

Cervical vertebræ Nos. 1, 2, and 3.

FIG. 1. Viewed from the side.
2. Viewed from in front.

PLATE 6.

Cervical vertebræ Nos. 4 (fig. 1), 5 (fig. 2) and 6 (fig. 3) viewed from in front.

PLATE 7.

Cervical vertebra No. 7 (fig. 1) and dorsal vertebra No. 1 (fig. 2) viewed from in front. Fig. 2 is slightly more reduced than fig. 1.

PLATE 8.

Cervical vertebræ Nos. 4 (fig. 1), 5 (fig. 2), 6 (fig. 3), and 7 (fig. 4); dorsal vertebra No. 1 (fig. 5) viewed from the side.

PLATE 9.

Cervical vertebra No. 6 viewed from in front.

FIG. 1. No. 236680 U. S. Nat. Mus. (Florida).
2. No. 34871 Amer. Mus. Nat. Hist. (Japan).

PLATE 10.

Dorsal vertebra No. 1. viewed from in front.

FIG. 1. No. 236680 U. S. Nat. Mus. (Florida).
2. No. 34871 Amer. Mus. Nat. Hist. (Japan).

PLATE 11.

Cervical vertebra No. 6 (figs. 1 and 2) and dorsal vertebra No. 1 (figs. 3 and 4) viewed from the side.

FIG. 1 and 3. No. 236680 U. S. Nat. Mus. (Florida).
2 and 4. No. 34871 Amer. Mus. Nat. Hist. (Japan).

PLATE 12.

Dorsal vertebræ Nos. 2–14 and lumbar vertebræ Nos. 1–5 viewed from the side.

PLATE 13.

Lumbar vertebræ Nos. 6–13 and caudal vertebræ Nos. 1–19 viewed from the side.

PLATE 14.

Lumbar vertebra No. 1 (fig. 1) and caudal vertebra No. 1 (fig. 2), viewed from in front.

PLATE 15.

Lumbar vertebra No. 1 (fig. 1) and caudal vertebra No. 1 (fig. 2), viewed from the side.

PLATE 16.

Right ribs viewed from behind.

PLATE 17.

Right scapula.

FIG. 1. Outer aspect.
2. Inner aspect.

PLATE 18.

Sternum (fig. 1).

Stylohyal (fig. 2).

Basihyal (fig. 3).

PLATE 19.

Jugal (figs. 1 and 2).

FIG. 1. No. 236680 U. S. Nat. Mus. (Florida).
2. No. 34871 Amer. Mus. Nat. Hist. (Japan).

Forearm (fig. 3).

PLATE 20.

Bones of the hand.

FIG. 1. Fourth lett metacarpal.
2. Second phalanx, second right digit.
3. First phalanx, second right digit.
4. First phalanx, first right digit.
5. Third left metacarpal.
6. Second left metacarpal.
7. First right metacarpal.

PLATE 21.

Lacrimals (figs. 1 and 2).
Baleen plate from near middle of series (fig. 3).

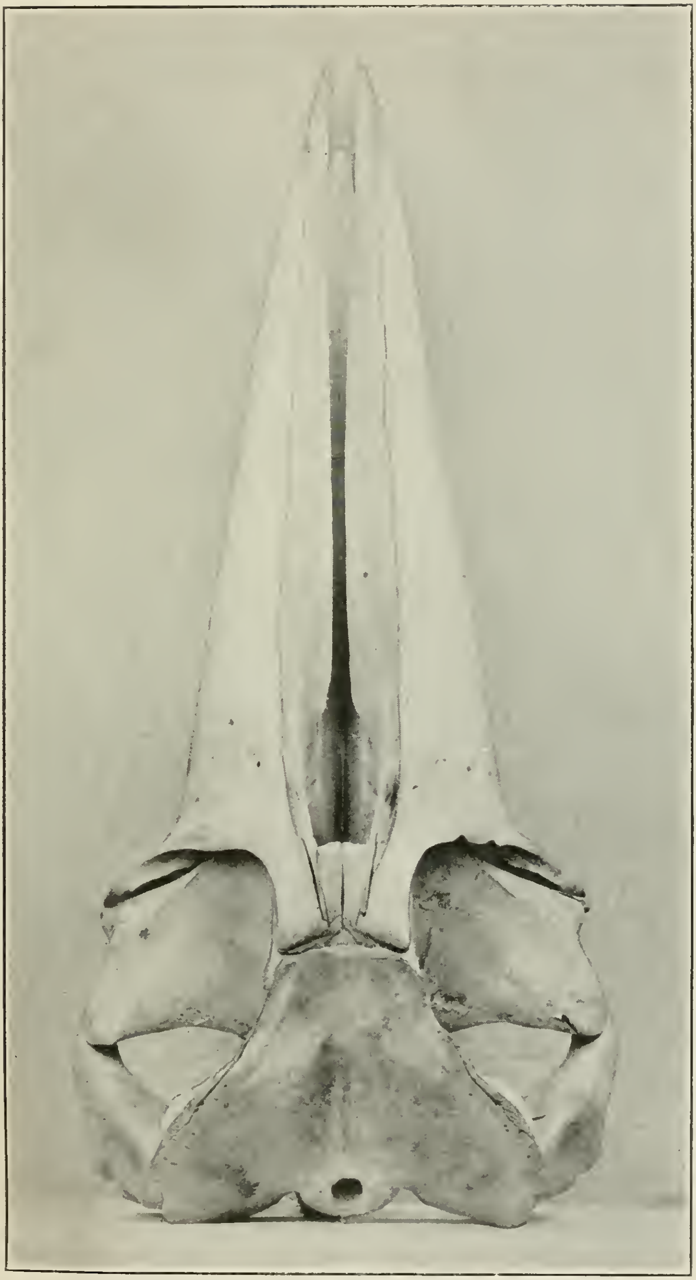
PLATE 22.

Tympanic and periotic bones.

FIG. 1. Outer aspect, tympanic in place.
2. Superior aspect, tympanic in place.
3. Outer aspect, tympanic removed.
4. Inner aspect, tympanic removed.

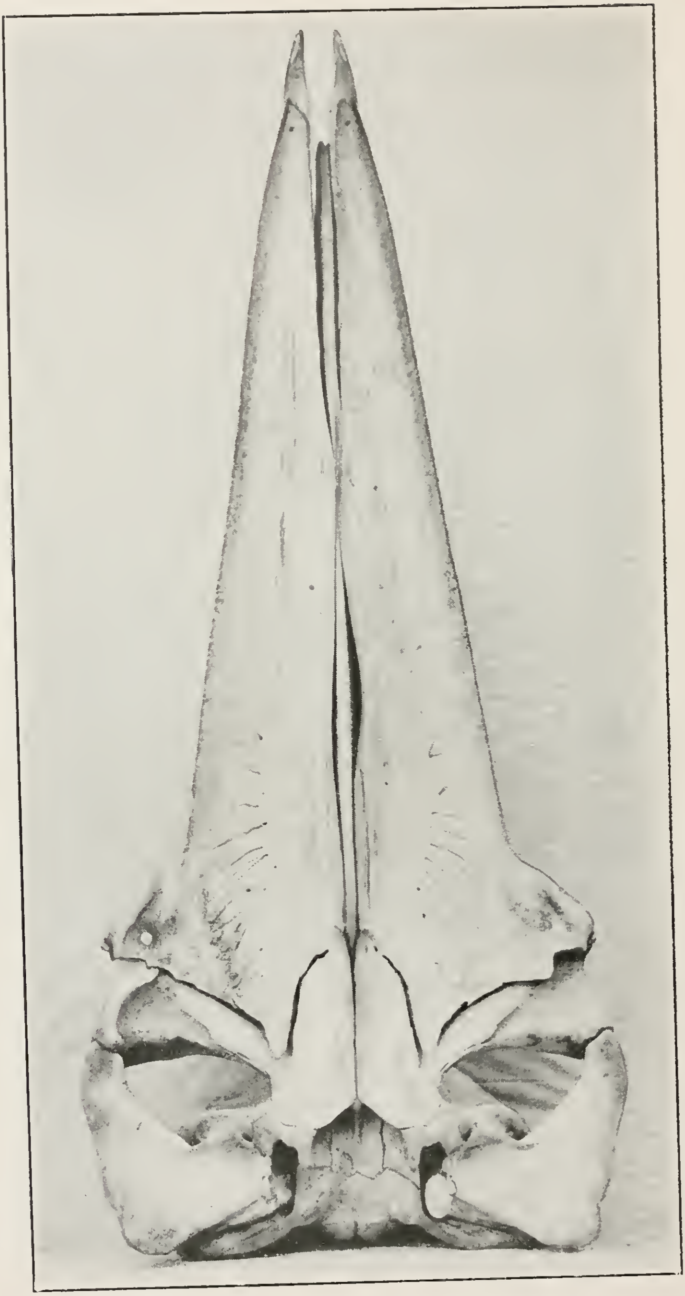
a. c. Aqueduct of cochlea.
a. p. Anterior petrous process.
a. v. Aqueduct of vestibule.
c. f. n. Channel for facial nerve.
f. c. Cerebral orifice of facial canal.
f. m. Fossa for head of malleus.
f. st. Fossa for stapedial muscle.
i.a.m. Internal acoustic meatus.
m. Malleus.
p. ap. Posterior apophysis of Beauregard.
p. p. Posterior petrous process.
s. p. Sigmoid process.
st. Stapes.

O



POLLACK WHALE: SKULL FROM ABOVE

FOR EXPLANATION OF PLATE SEE PAGE 13



POLLACK WHALE: SKULL FROM BELOW

FOR EXPLANATION OF PLATE SEE PAGE 13

POLLACK WHALE: SKULL FROM THE SIDE

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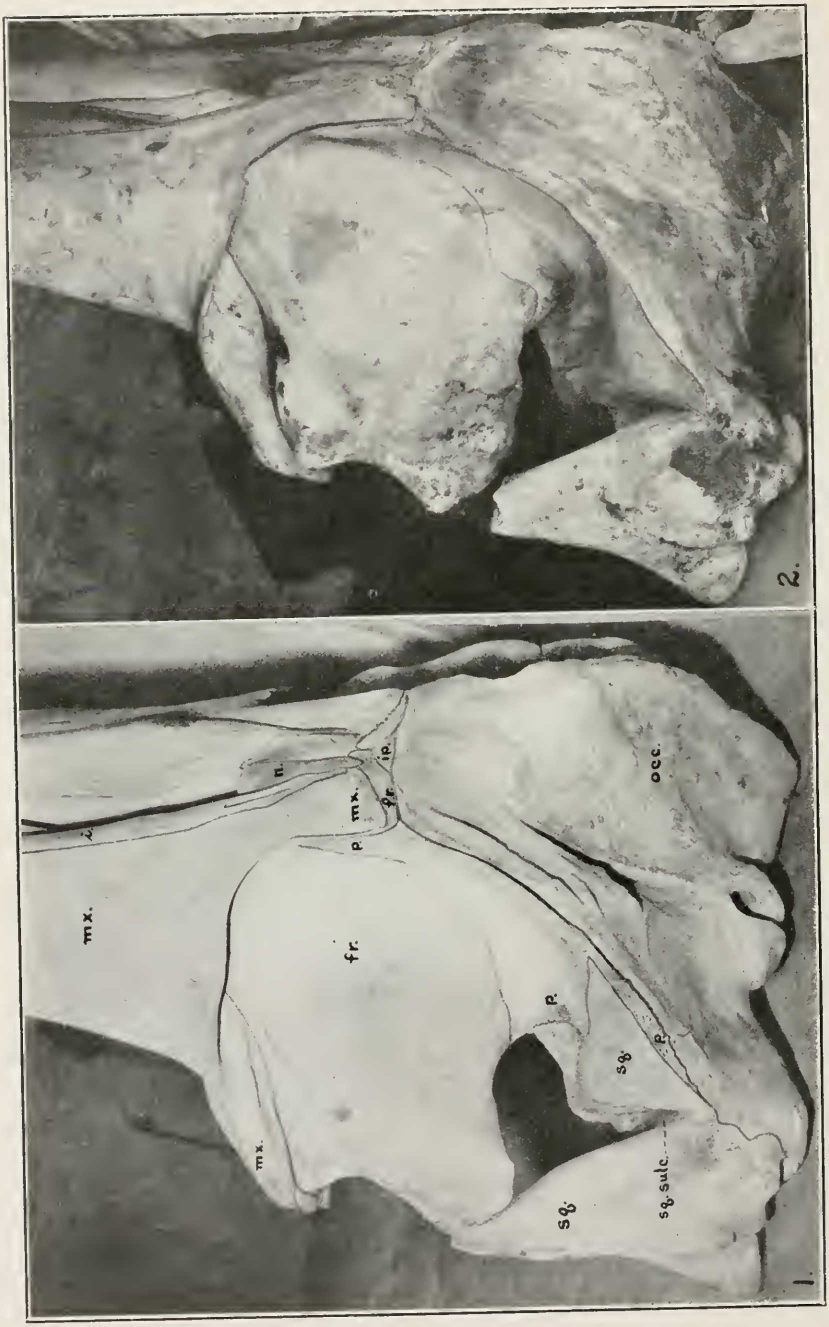
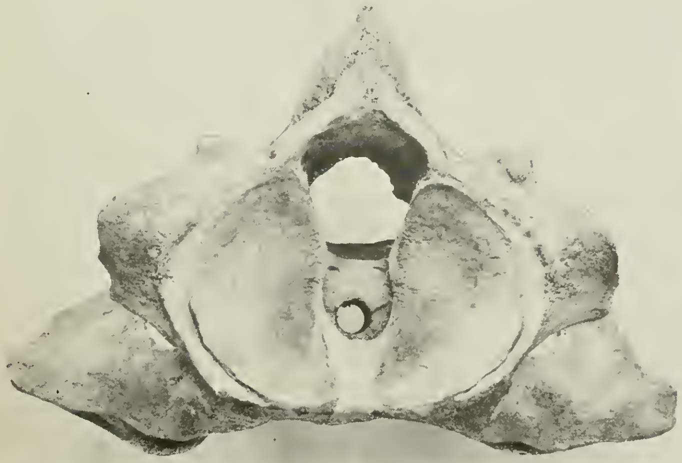


POLLACK WHALE: OBLIQUE VIEW OF BRAINCASE

FOR EXPLANATION OF PLATE SEE PAGE 13

1



2.

POLLACK WHALE: CERVICAL VERTEBRÆ NOS. 1, 2, AND 3

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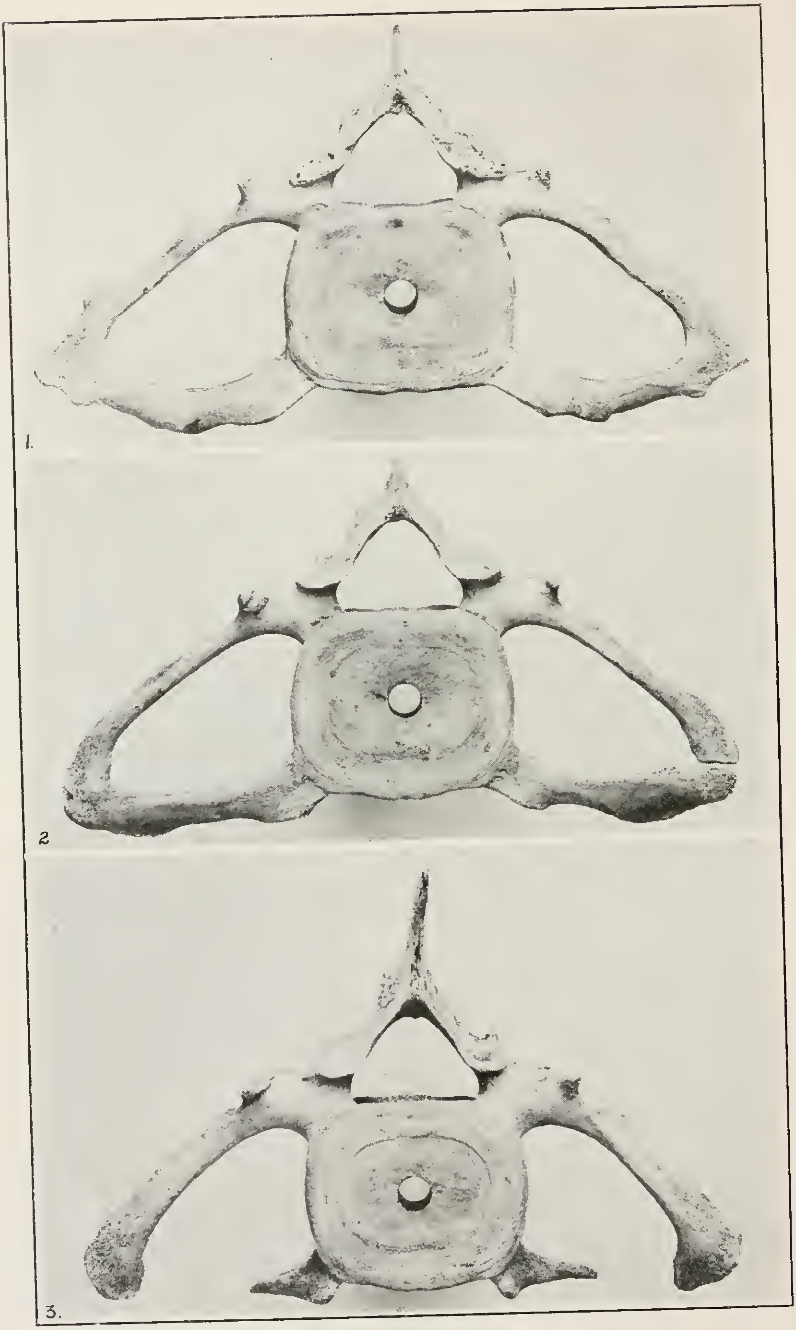
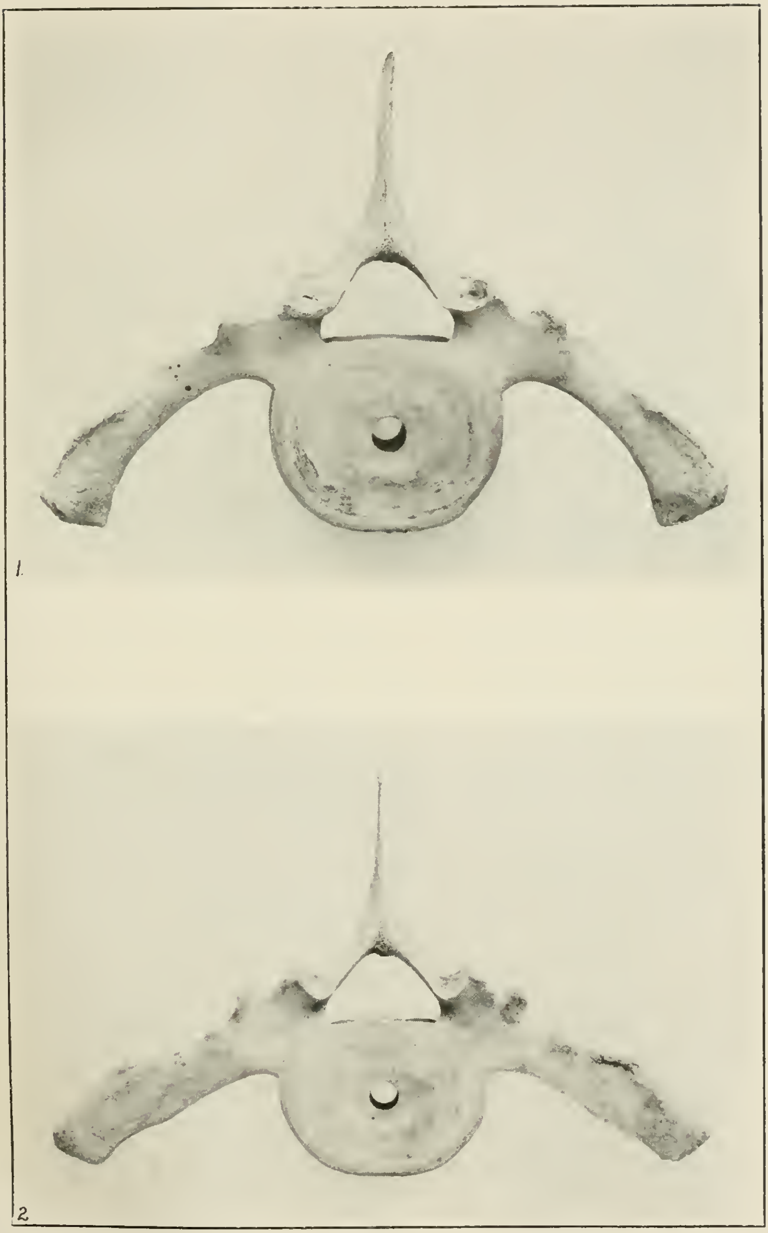


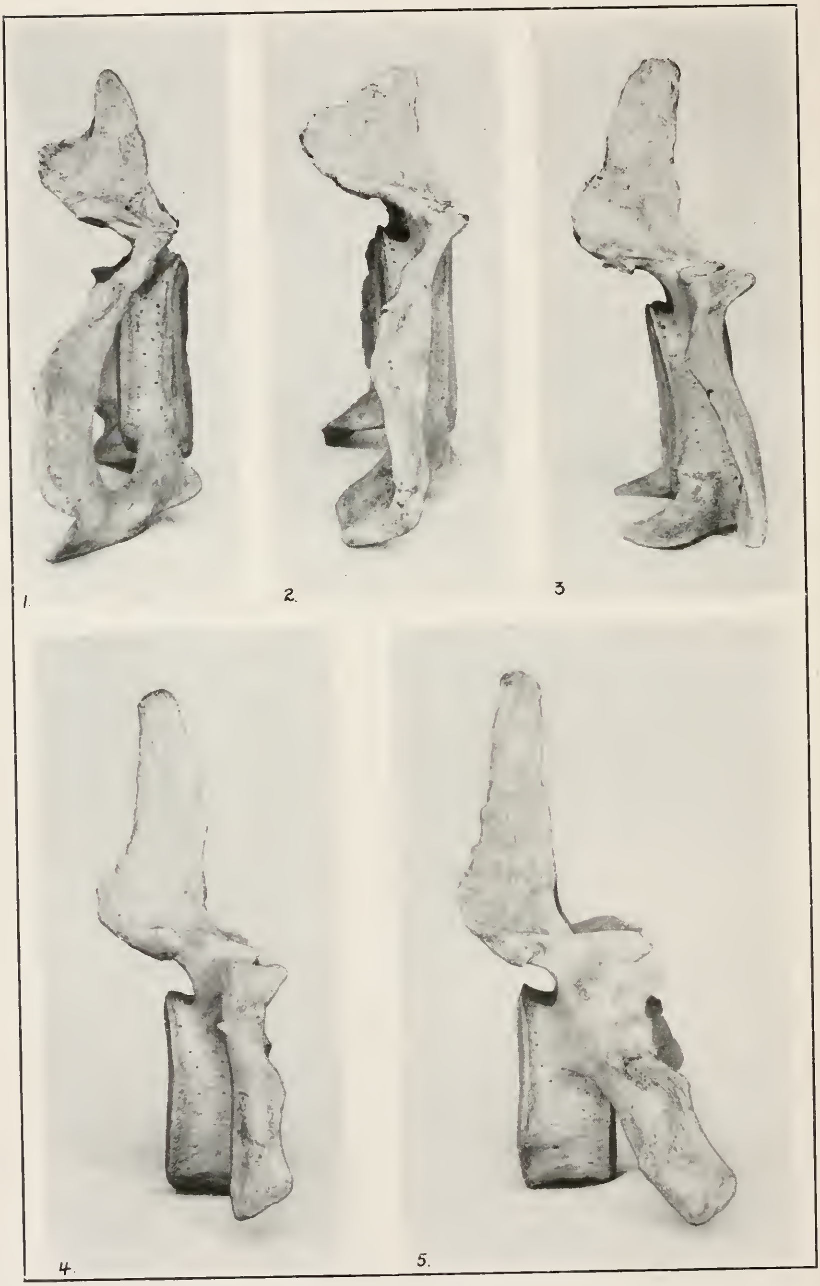
Pollack Whale: Cervical Vertebræ Nos. 4, 5, and 6

For explanation of plate see page 13



Pollack Whale: Cervical Vertebra No. 7 and Dorsal Vertebra No. 1

For explanation of plate see page 13



POLLACK WHALE: CERVICAL VERTEBRÆ NOS. 4, 5, 6, AND 7: DORSAL VERTEBRA NO. 1

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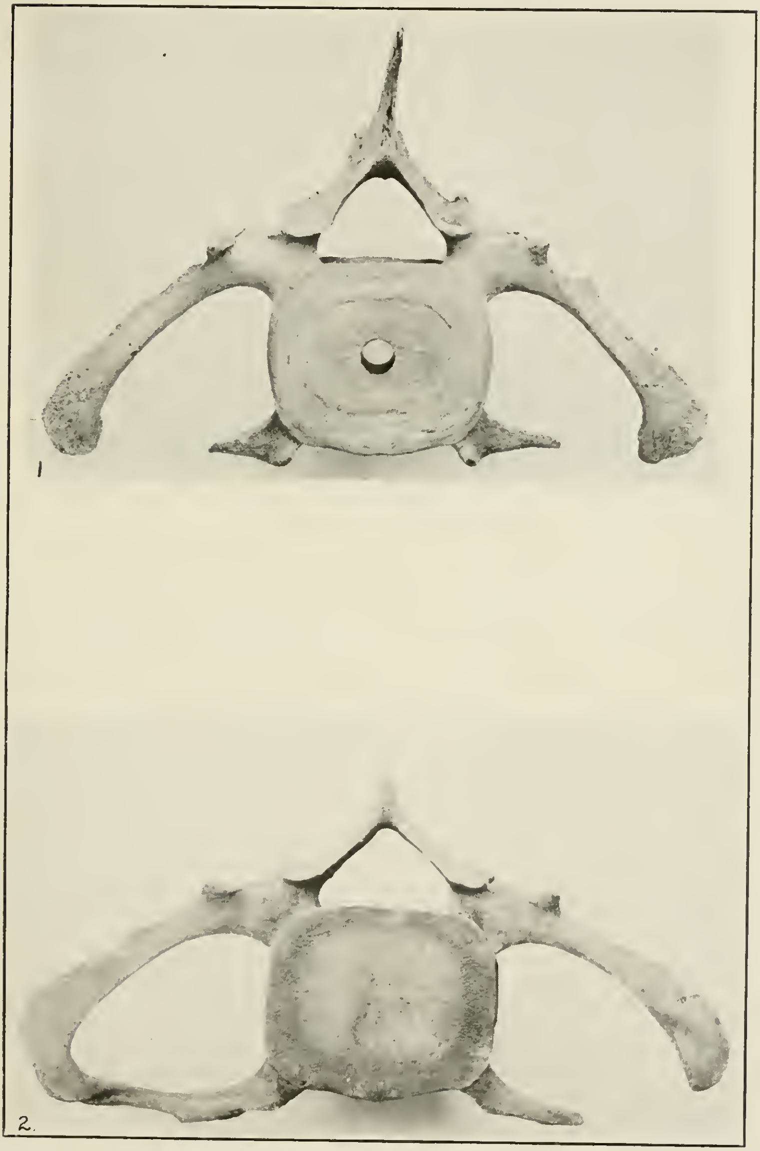

POLLACK WHALE: CERVICAL VERTEBRA No. 6

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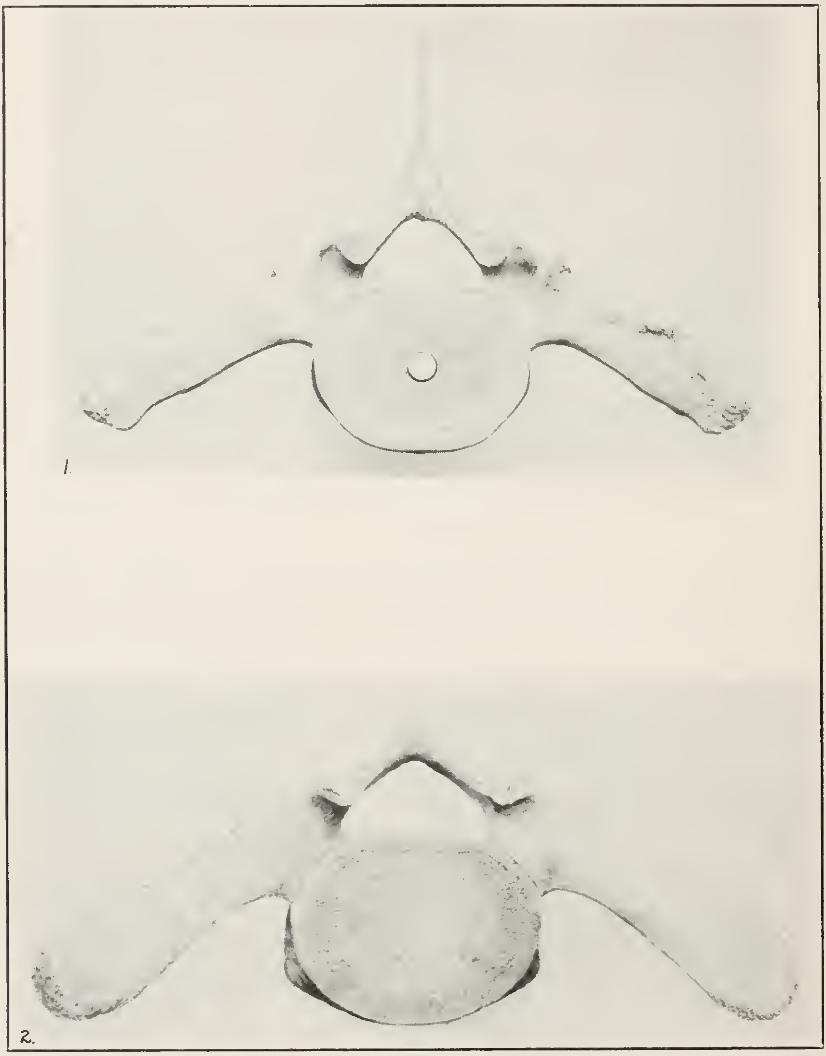

POLLACK WHALE: DORSAL VERTEBRA NO. 1

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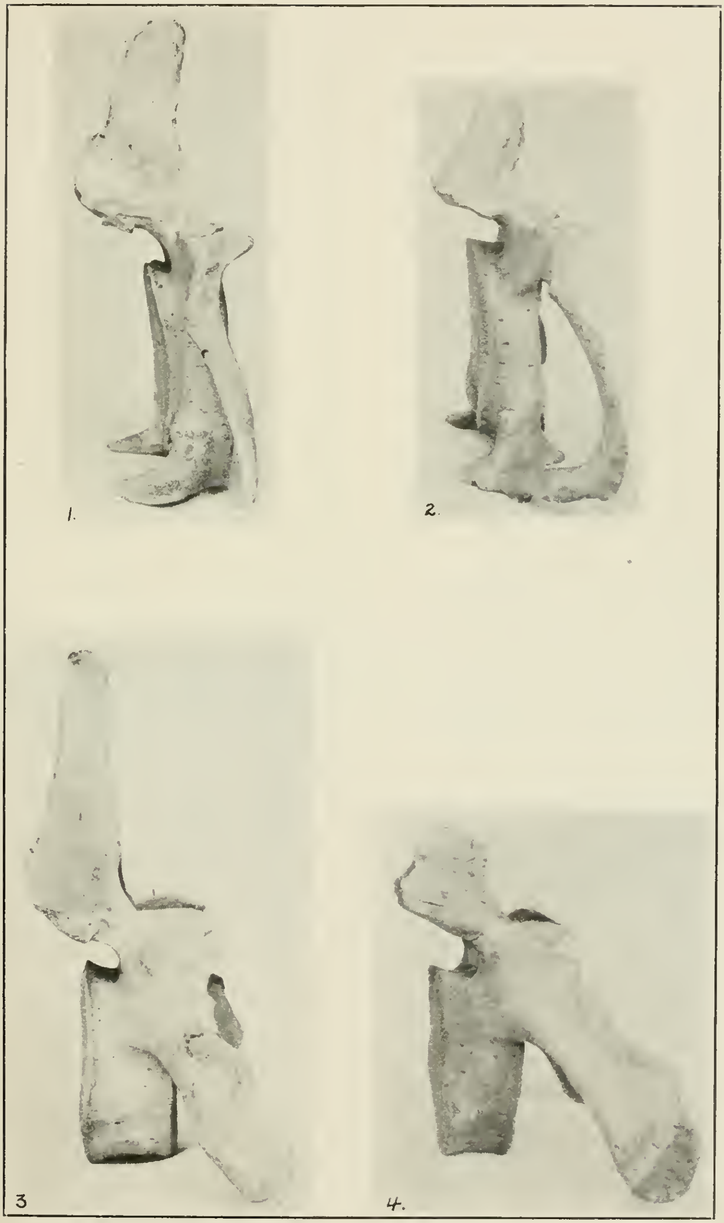

POLLACK WHALE: CERVICAL VERTEBRA NO. 6 AND DORSAL VERTEBRA NO. 1

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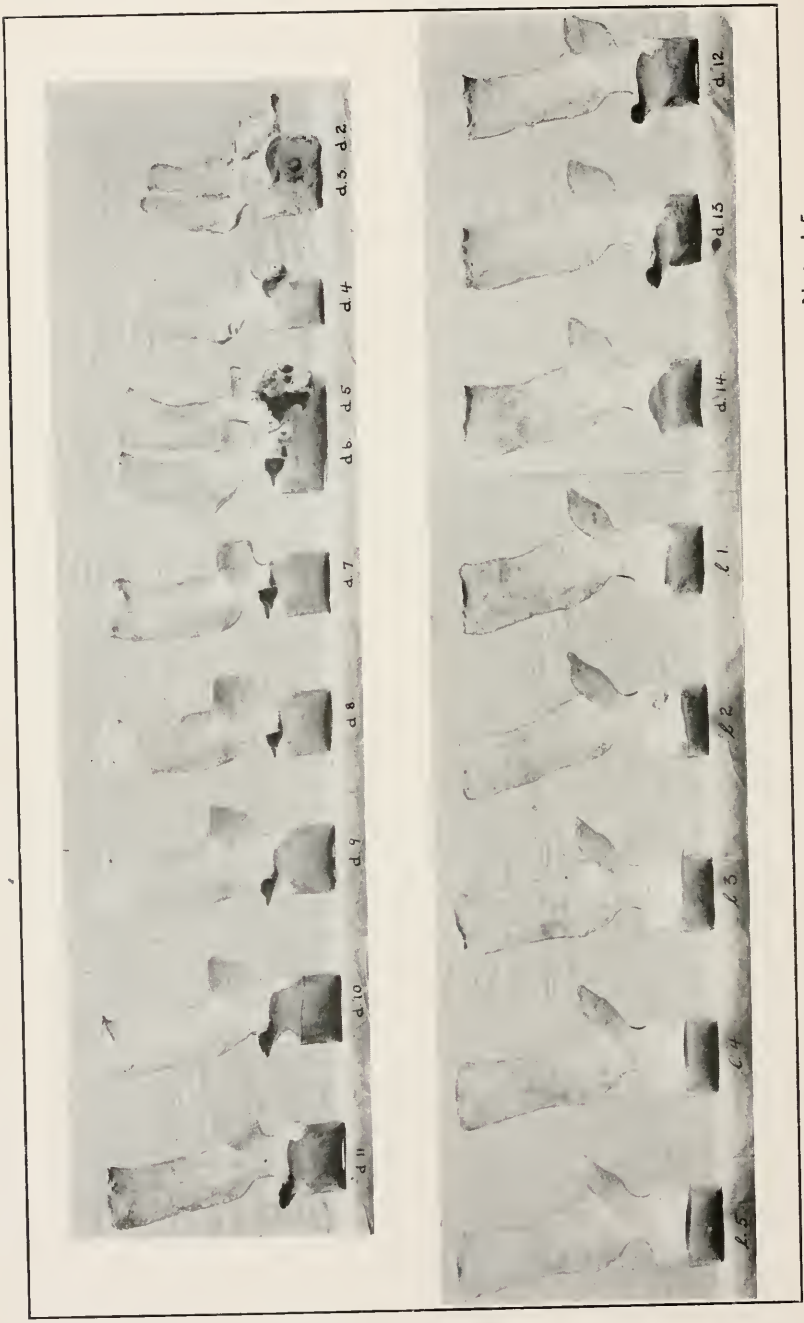

POLLACK WHALE: DORSAL VERTEBRÆ NOS. 2-14 AND LUMBAR VERTEBRÆ NOS. 1-5

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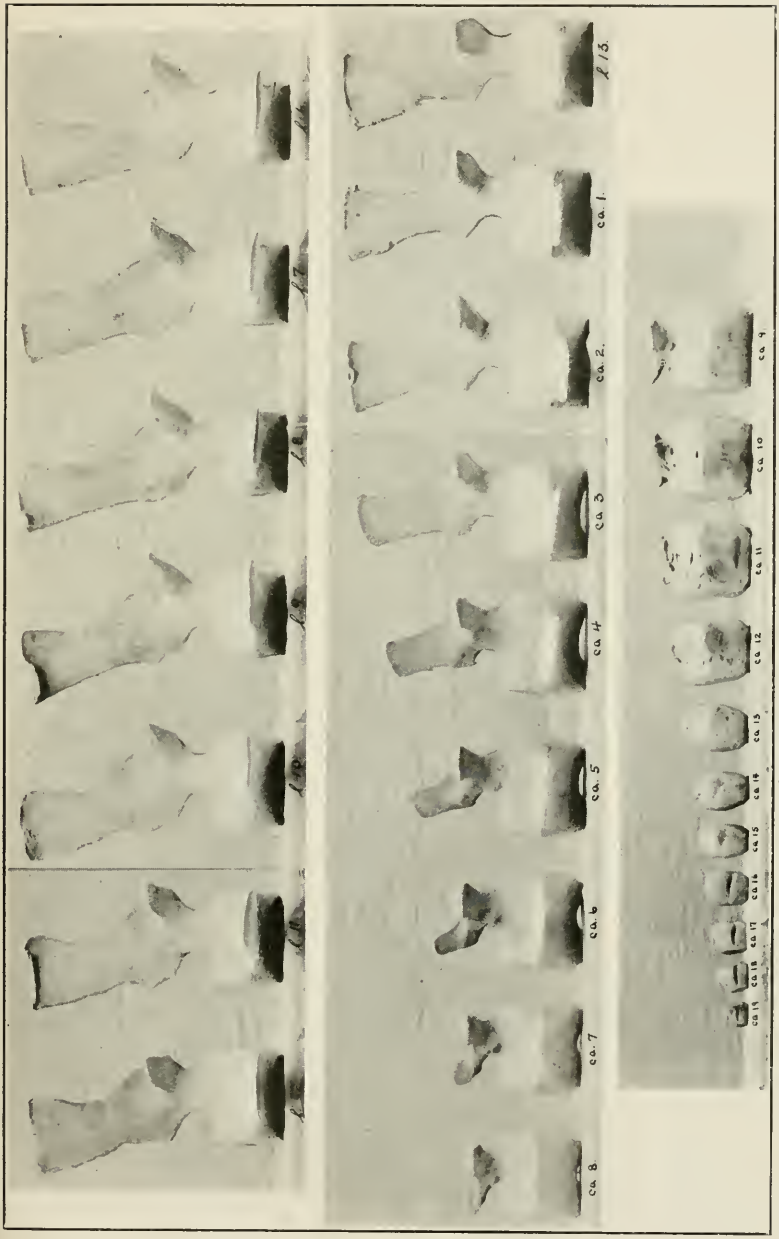

POLLACK WHALE: LUMBAR VERTEBRÆ NOS. 6-13 AND CAUDAL VERTEBRÆ NOS. 1-19

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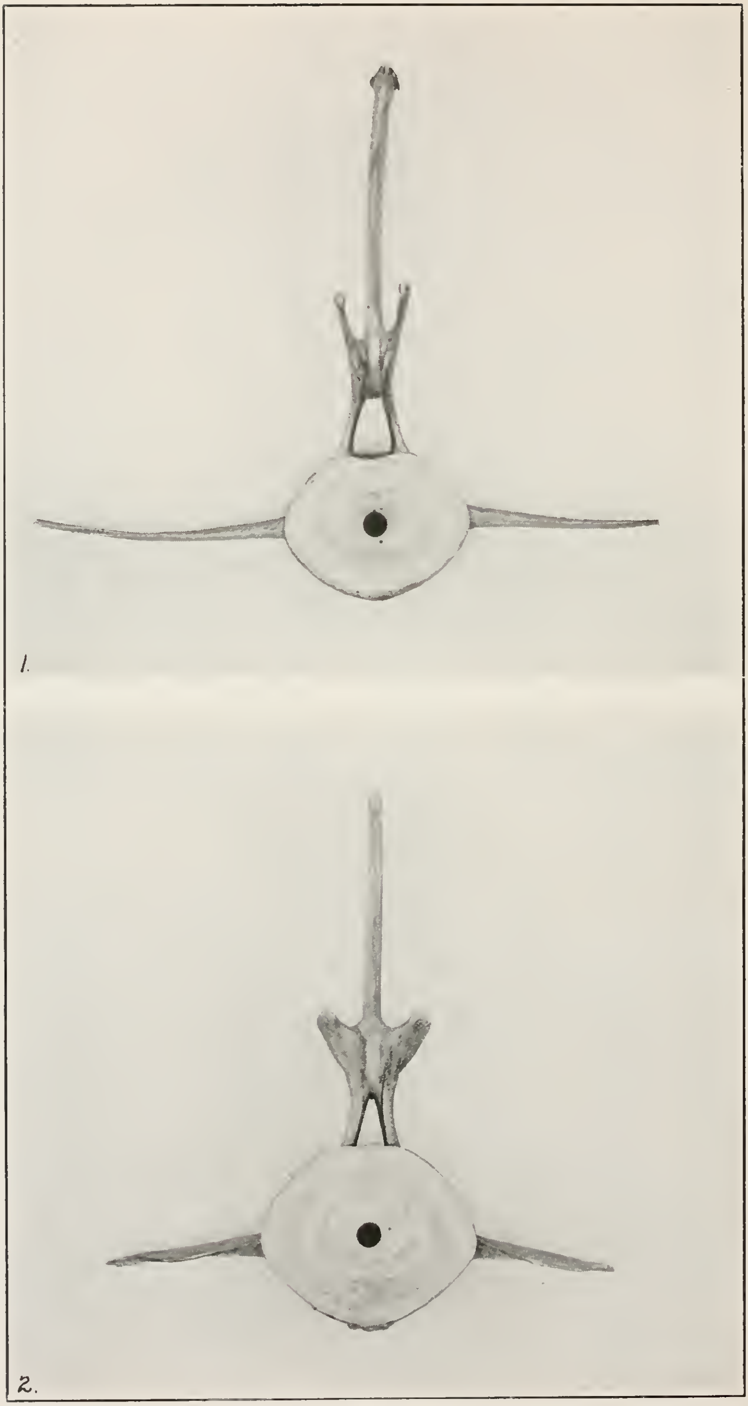

POLLACK WHALE: LUMBAR VERTEBRA NO. I AND CAUDAL VERTEBRA NO. I

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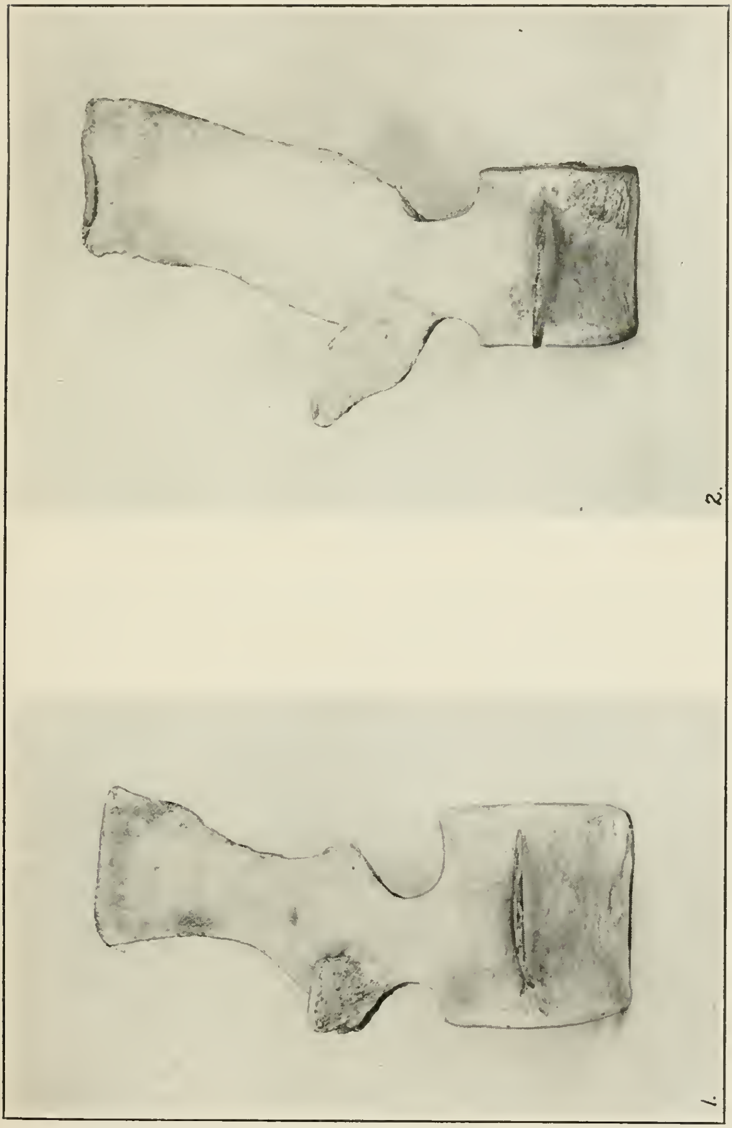

POLLACK WHALE: LUMBAR VERTEBRA NO. 1 AND CAUDAL VERTEBRA NO. 1

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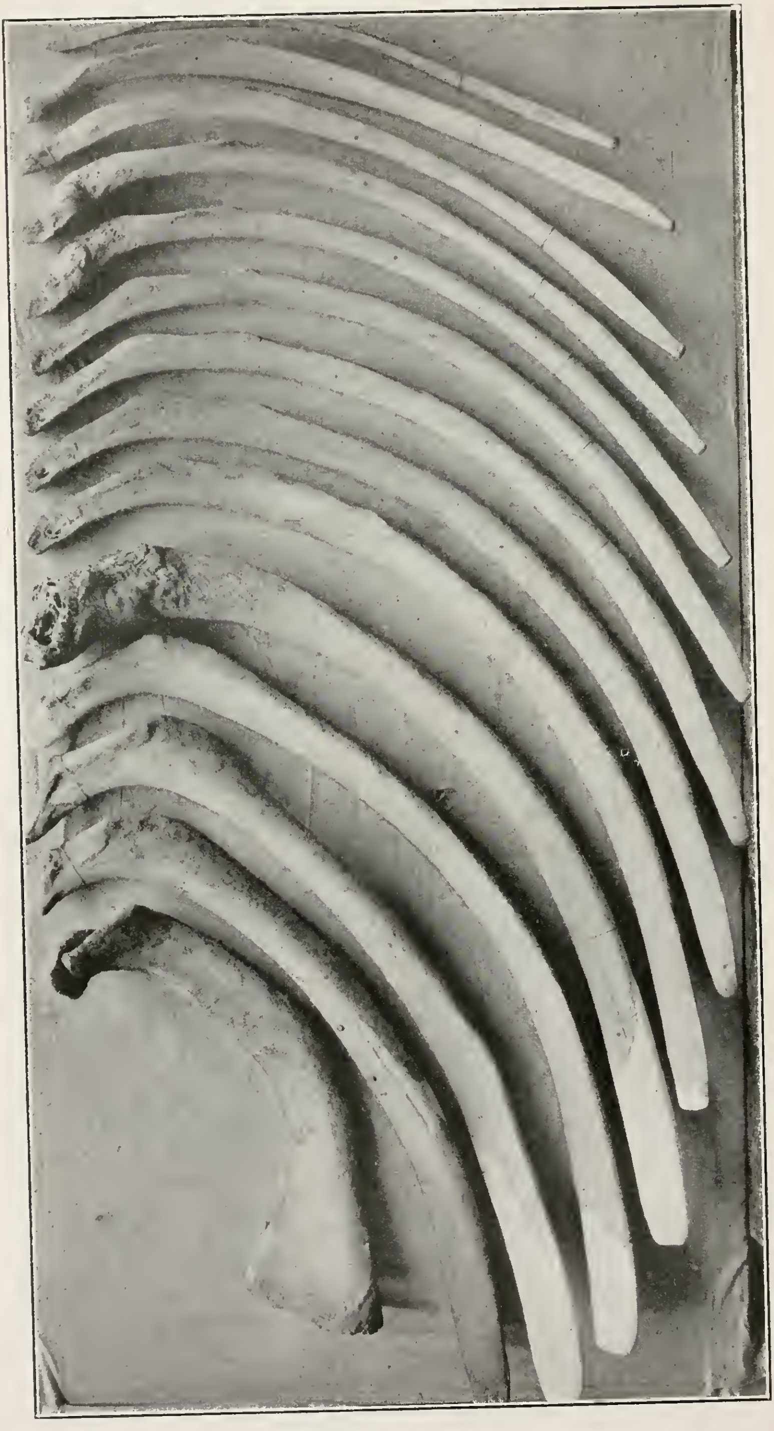

POLLACK WHALE: RIGHT RIBS

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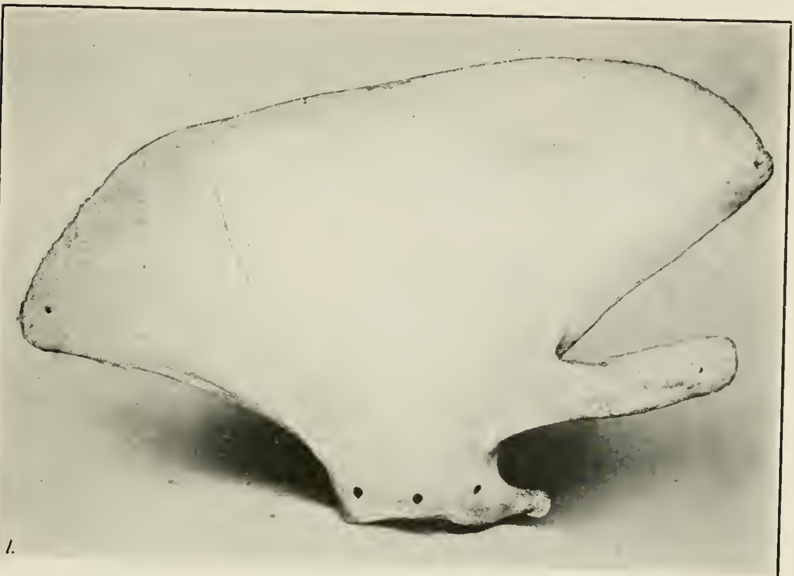
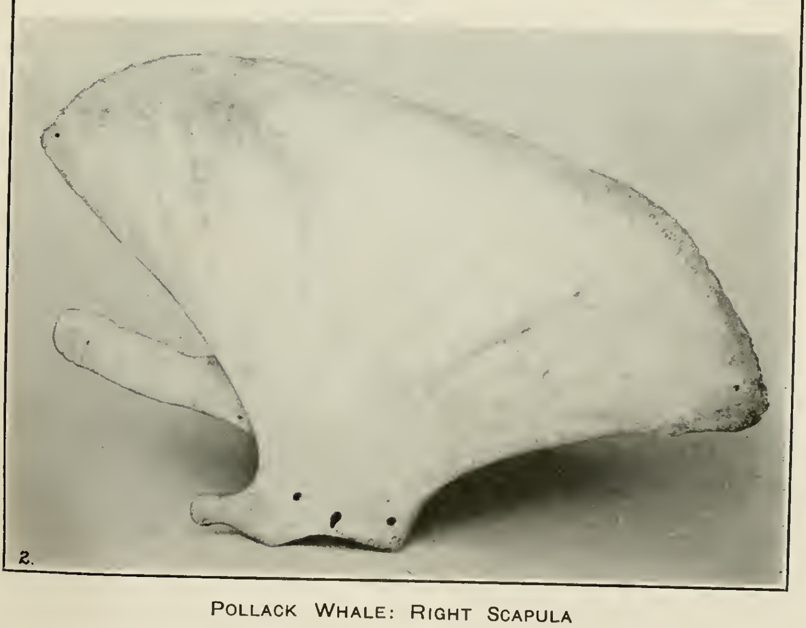


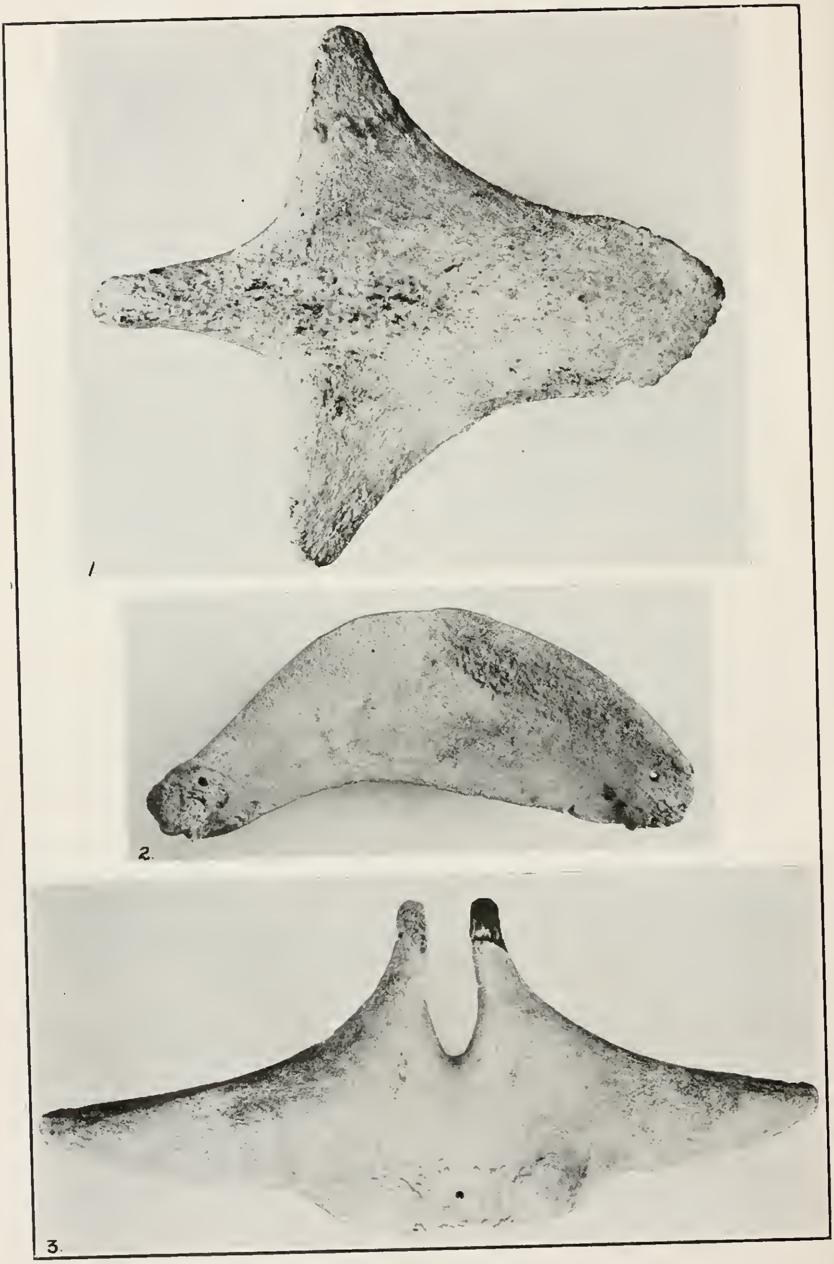
1.



2.

Pollack Whale: Right Scapula

For explanation of plate see page 14



POLLACK WHALE: STERNUM, STYLOHYAL, AND BASIHYAL

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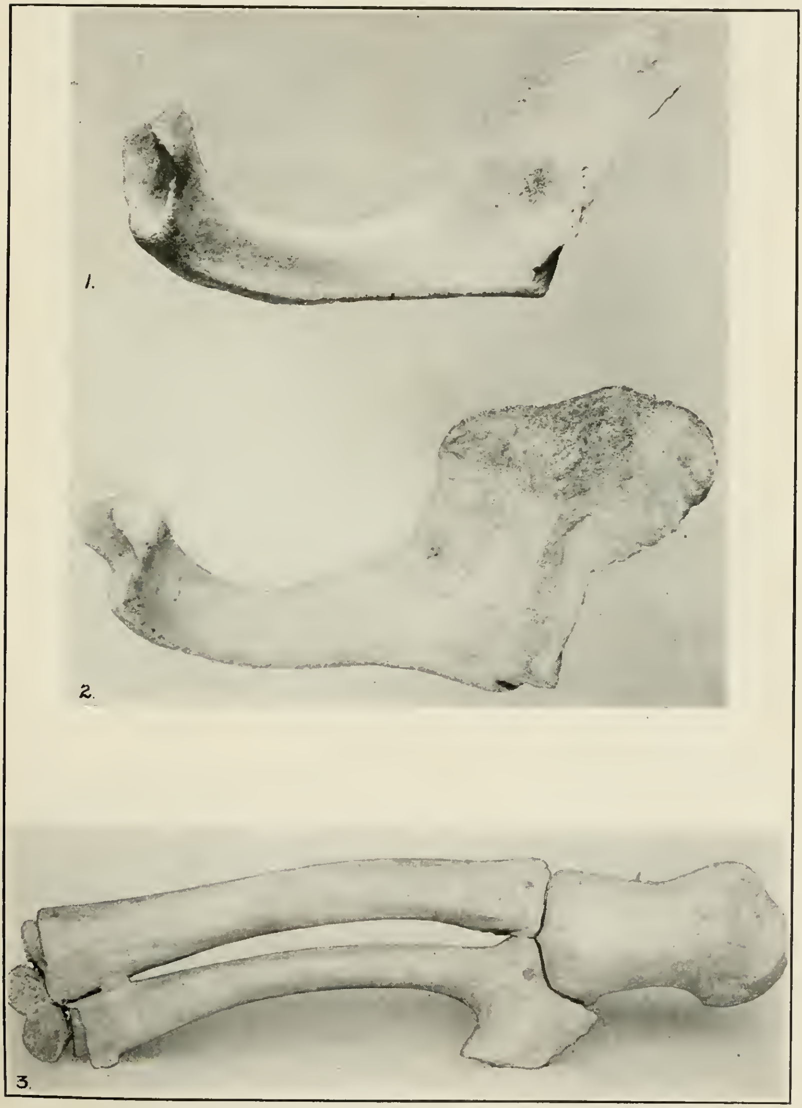
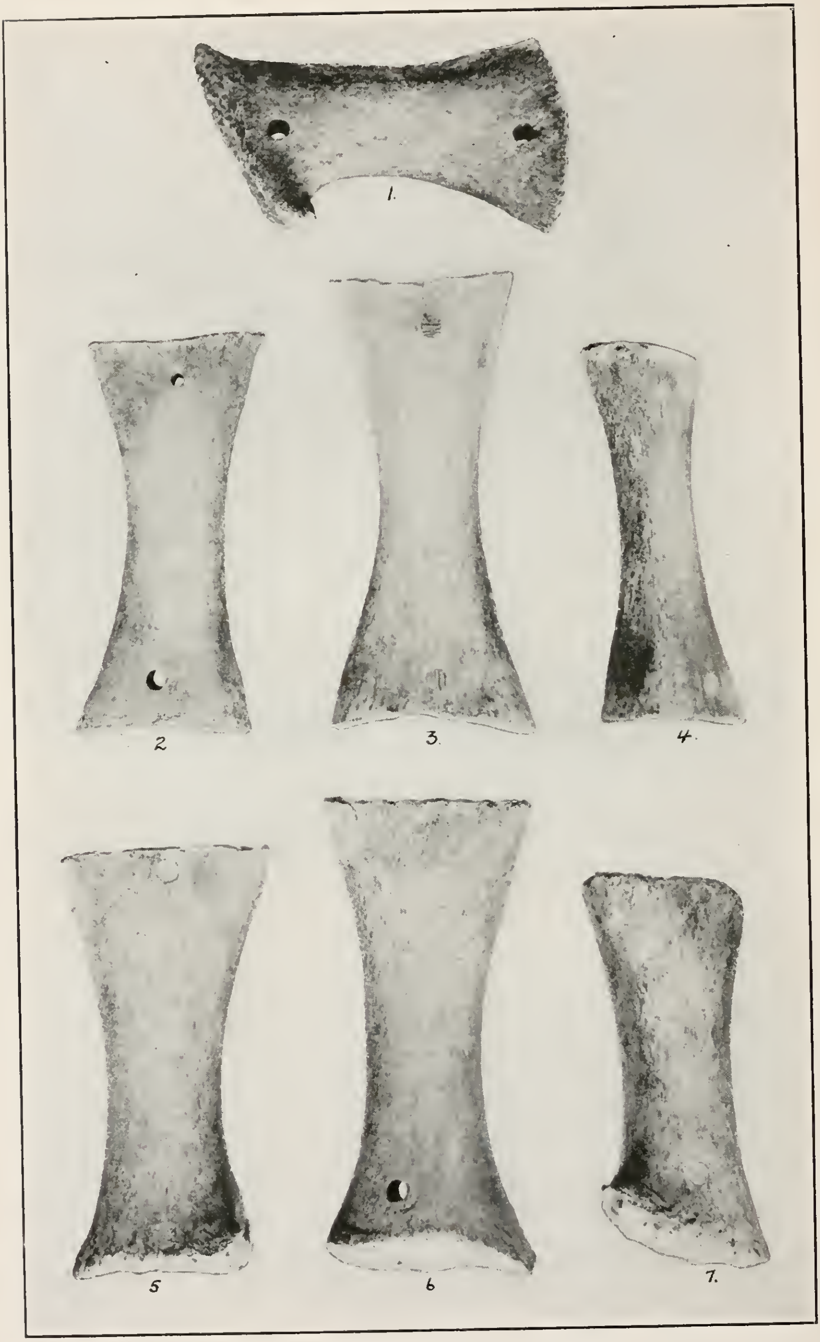


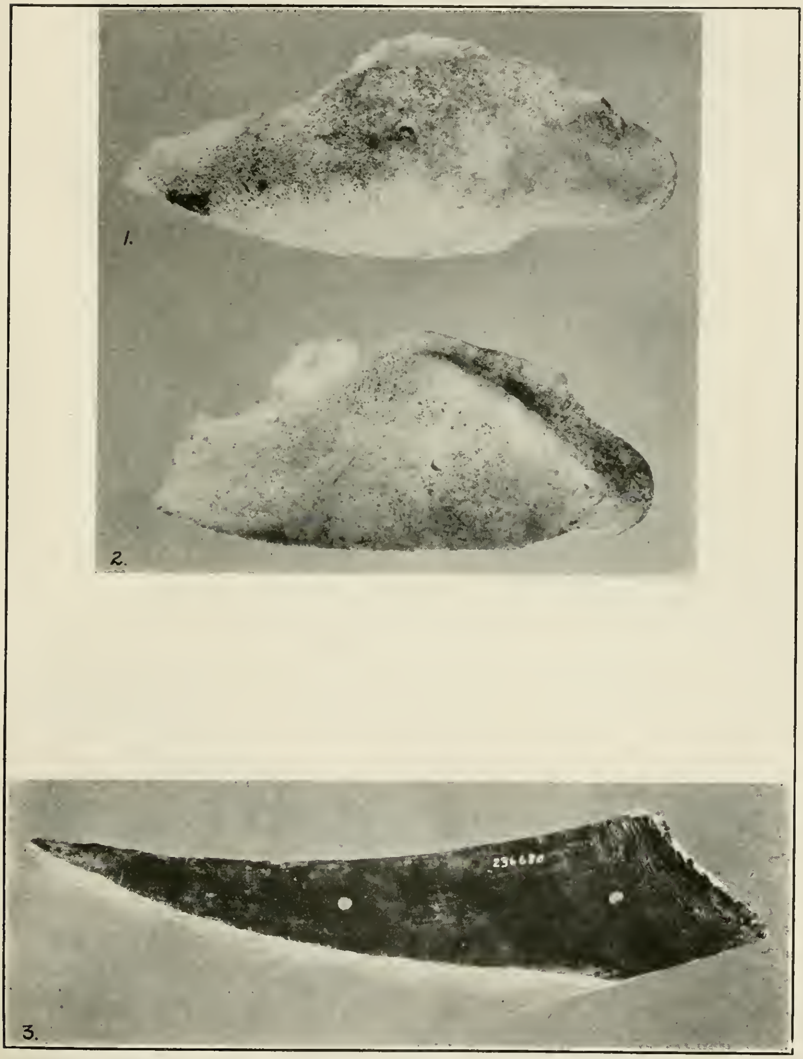
Pollack Whale: Jugal and Forearm

For explanation of plate see page 15



Pollack Whale: Bones of the Hand

For explanation of plate see page 15



POLLACK WHALE: LACRIMALS AND BALEEN PLATE FROM NEAR MIDDLE OF SERIES

FOR EXPLANATION OF PLATE SEE PAGE 15

POLLACK WHALE: TYMPANIC AND PERIOTIC BONES

FOR EXPLANATION OF PLATE SEE PAGE 15

NOTES ON ORIENTAL DRAGONFLIES OF THE GENUS ACIAGRION.[1]

By Frank Fortescue Laidlaw,
of Uffculme, England.

INTRODUCTION.

In accordance with the hope I entertain of completing, some day, a survey of the Oriental Odonata fauna, I have contributed in this paper an account of the genus *Aciagrion* to be followed, I trust, in due course by similar accounts of other genera of the Coenagrioninae.[2] As no monographic revision of this subfamily has as yet appeared, it seems advisable to deal with the genera of the subfamily in more detail than is necessary, for example, in the case of the Libellulinae. As the systematic arrangement of the Coenagrioninae is still largely unsettled the method of dealing with it, genus by genus, has considerable advantages, since by a careful examination of the evidence available it should be possible to obtain some data of use to those who will undertake the task of constructing a natural classification of the subfamily which should have some right to be considered final.

Genus ACIAGRION de Selys.

Aciagrion de Selys, Ann. Mus. Civico di Genova, vol. 30, p. 159 (pp. 77–79 of separate). *Type of genus.—Aciagrion hisopa* de Selys.

The genus includes a number of small, delicate insects, and ranges, so far as known at present, from Ceylon and South India to the East Himalayas, thence through Assam and Burma down the Malay Peninsula to Borneo, whilst an outlying species is recorded by Tillyard from Australia.

[1] This is the fourth of a series of papers, the first and second of which, by E. B. Williamson, of Bluffton, Ind., were on The Dragonflies (Odonata) of Burma and Lower Siam, as follows: 1. Subfamily Calopteryginae, Proc. U. S. Nat. Mus., vol. 28, pp. 165–187, published April 22, 1905. 2. Subfamilies Cordulegasterinae, Chlorogomphinae, and Gomphinae, Proc. U. S. Nat. Mus., vol. 33, pp. 267–317, published December 13, 1907.

The third paper in the series, by Frank Fortescue Laidlaw, of Uffculme, England, carrying the same general title of The Dragonflies (Odonata) of Burma and Lower Siam—III, was on the Subfamily Aeschninae and was published in the Proc. U. S. Nat. Mus., vol. 62, pp. 1–29, pl. 1, and was issued on June 21, 1923.

[2] Coenagrioninae=Legion Agrion of de Selys. See Kennedy, Ohio Journal of Science, vol. 21, pp. 27–28, 1920.

Amongst old world genera it is rivaled only by *Amphicnemis* for extreme delicacy, though structurally it does not seem particularly closely allied to that genus.

The species are probably abundant in suitable localities, and it is likely that several new forms await discovery. The fragility of papered specimens makes it difficult in many cases to determine satisfactorily the more minute details of structure, more especially the anal appendages of the male. Hence it is often difficult to give adequate descriptions or clear figures of these structures. Moreover, in papered specimens the colors are very likely to be faded, so that the discrimination of species is not always an easy matter.

The genus may be defined as follows: A coenagrionine genus, with short tibial spines and a rounded frons. Wings petiolated to level of *ac*, this lying about halfway between the first and second antenodals. Costal margin of quadrangle about one-third the length of the anal margin in the forewing, about one-half in the hind wing. Rs arising from vein descending from nodus, M_3 from a point immediately proximal to it. Pterostigma of forewing distinctly larger than that of hind wing. Female with spine at apex of eighth sternite of abdomen. Male with apex of terminal segment deeply emarginate and slightly elevated. Upper anal appendages more or less bifid, lower appendages rather flattened, each of these latter carrying on its upper part a thickened process which may be separated by a cleft from the rest of the appendage so as to stand out from it as a strong conical spine.

In the species examined for this structure the penis has the distal part of the shaft armed with fine lateral spines. The third segment (employing Kennedy's nomenclature) has a well-developed internal fold; the terminal fold is present but reduced. The inner surface of the distal lobe of the third segment is armed with a number of fine shagreenlike denticles, and the lateral margin of this lobe carries a strong spine on either side. Its apex may be cornuate (*A. borneense*) or simple and rounded (*A. hisopa*). Lastly, the coloring of the two sexes is similar, no dimorphic females have been known to occur, and postocular spots are present.

The relationship of the genus is evidently with the *Enallagma* series of genera. It resembles them in the shape of the frons, in the presence of a spine on the eighth segment of the abdomen of the female, in the similar coloring of the two sexes, and in the postocular markings. It differs, I think, from all of them in the greater amount of petiolation of the wings, and in the extremely slender build of the body.

It resembles some of the American species of *Enallagma*, and the African *Proischnura subfurcatum* (de Selys) in having the pteros-

tigma of the forewing larger than that of the hind wing, whilst the anal appendages of the males of some of the species at least (*A. tillyardi*, *A. olympicum*) bear a strong resemblance to the corresponding structure of some of the African species, *Africallagma glaucum* (Burmeister)[3] for example.

On the whole we may conclude that the genus is a specialized end-branch of the great *Enallagma* series.

In the following table I have attempted to give the differential characters of all the species (six in number) which I have been able to identify in the material available to me. To make the table as complete as possible I have added a note on species I have not seen, derived from the descriptions given by the author in each case.

In this table the expressions "moderate size," "rather large" must be taken as relative only.

a.[1] With blue coloring on abdomen, the blue being especially vivid on the first three and on the last three segments. Head and synthorax also with blue markings, the latter with blue antehumeral stripes, and with the sides blue.

b.[1] Species of moderate size (abdomen of male 24–26 mm., of female 24 mm.; hind wing of male 15–16 mm., of female 16–17 mm.). In the male, segments 8, 9, 10 of abdomen entirely blue (or in specimens from some localities segment 8 has small, paired, black basal markings on the dorsum). Female similar, but blue less vivid, and segment 8 has a longitudinal, black band on the dorsum not reaching the apex of the segment, whilst 9 has small, paired, basal spots. Postnodal nerves on forewing 10–11.
A. hisopa de Selys.

b.[2] Species of moderate size (abdomen of male 24.5 mm., of female 22.5 mm.; hind wing of male 17.5 mm., of female 17.5 mm.). Rather robust for its size when compared with other species of the genus. In both sexes the last three segments of the abdomen are definitely dilated. In the male, segments 8 and 9 of abdomen bright blue, dorsum of segment 10 black. The female has a dorsal, black band on segments 8 and 9, not quite reaching the apex of 9, whilst 10 is apparently blue, unmarked with black. Postnodal nerves on forewing 12____________________**A. tillyardi** Laidlaw.

b.[3] Small species (abdomen of male 22–24 mm., of female 23 mm.; hind wing of male 15 mm., of female 15.5 mm). Very slender. In the male, segments 8, 9, 10 rich blue, 8 with a black, dorsal triangle, its apex anterior but not usually reaching the base of the segment, 9 entirely blue, 10 has a black X-shaped mark on the dorsum. Female with a broad dorsal band of uniform width on 8, segment 9 with a broad basal triangular mark of black, 10 entirely blue. Postnodal nerves on forewing 9.
A. occidentale Laidlaw.

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[3] I have used Kennedy's generic names here. It seems to me convenient to distinguish African from American forms by according to them subgeneric rank where there is structural modification sufficient to justify such a proceeding.

a.[1] With blue coloring on abdomen, etc.—Continued.

b.[4] Very small species (abdomen of male 19 mm., of female 18 mm.; hind wing of male 13 mm., of female 13.5 mm.). In the male, segment 8 has a dorsal band of uniform width of black, and 10 has a dorsal, black mark relatively broader than in the last species; 9 is usually entirely blue, but some specimens have a diamond-shaped, black mark on the dorsum of this segment also. The female has the whole dorsal surface of 8 and 9 covered with a broad black band, narrowing apically on 9, whilst 10 has a basal bilobed black mark. Postnodals 8 or 9_______ **A. borneense Ris.**

a.[2] Without any blue coloring on abdomen.

b.[1] Rather large species (abdomen of male 34 mm., of female 32 mm.; hind wing of male 22 mm., of female 22.5 mm.). Ground color generally creamy-white; rather darker on sides of synthorax and of segments 1, 2, 3 of abdomen. In the male, segments 8, 9, 10 are without markings, 2 has an isolated triangular black mark on the distal half of the dorsum surrounded by a pale margin; 3 to 7 with black dorsal bands widened apically on each segment, pointed basally in 3. The female has a longitudinal black band on the dorsum of segments 2 to 7 of the abdomen, and 8 has a black, dorsal mark, narrow basally, widening distally, but not touching either end of the segment. Thirteen postnodals on forewing. Each femur marked with black line in both sexes________________________________ **A. olympicum Laidlaw.**

b.[2] Species of moderate size (abdomen of male 28 mm., of female 29 mm.; hind wing of male 18 mm., of female 19 mm.). Very fragile and slender. In the adult male the ground color of the dorsum of the head and thorax appears to be a dull blue with a greenish tinge. In immature males, and in females this color is replaced by fawn color. Antehumeral stripes not so sharply defined as in other species. Ground color of abdomen white or buff-white of a warmer tone on the dorsum. Segments 1 to 7 each with a longitudinal dorsal band of metallic green. Segments 8, 9, 10 without markings. In immature males and females the dorsal band is present on the first and second segments and on the base of the third; it is also well developed on segments 6 and 7. In both sexes the femora are without markings, but the joints of the legs, and the spines, are brownish. Postnodals 10 to 12.

A. pallidum de Selys.

a.[3] Species which are not known to me.

b.[1] **A. approximans** (de Selys).

This species has never been fully described. It is said by de Selys to be related to *A. hisopa* in venation and by the form of the anal appendages. The last 3 segments of the abdomen of the type are missing. The female is unknown. Said to come from the Kjasi Hills. Abdomen of male 27 mm. (approximately); hind wing 17.5 mm. (Possibly *A. tillyardi* is synonymous, but the anal appendages of that species are strikingly different from those of *A. hisopa* in appearance.)

a.[3] Species which are not known to me—Continued.

b.[2] A. fragilis Tillyard.

Postocular markings blue. Narrow antehumeral stripes and sides of synthorax blue, legs gray. Abdomen of male with segments 1 to 8 black, with narrow, transverse, white lines along the sutures. Segment 2 marked with blue at the sides as is 7. Segment 9 bright blue, 10 black above, blue at the sides. Female as in the male, but segment 8 has the sides, base and apex blue, 9 has a bronze basal spot, and 10 is blue. Postnodal nerves in forewing 9. Length of abdomen of male 22 to 23 mm.; hindwing 14 mm.

b.[3] A. azureum Fraser.

Rather large species (abdomen of male 30 mm.; hind wing 20 mm.). Markings on head pale yellow, but with large blue postocular spots. Few blue antehumeral stripes on synthorax, sides blue, changing to creamy yellow below. Abdomen with ground color of segments 1 to 2 and 8 to 10 blue; black markings on the dorsum of 1 to 7; the last three segments unmarked. Anal appendages similar to those of *A. olympicum*, the upper pair more conical and not bifid, black in color. Postnodal nerves on forewing 10 to 11. Said to be very like *A. olympicum*.

ACIAGRION HISOPA de Selys.

Plate 1, fig. 8.

Aciagrion hisopa DE SELYS. Ann. Mus. Civico di Genova, vol. 30, p. 159 (pp. 80–81, separate).

Specimens examined.—Four males and three females from Pulau Ubi, a small island near Singapore, and the Botanic Gardens at Singapore. One female from Biserat in Jalor (Siamese Malay State), N. Annandale. Two males and two females from Burma, collection E. B. Williamson, collected by R. A. Earnshaw.

None of these spicemens is in good condition, and it is not possible to make a satisfactory figure of the anal appendages of the male. I have, however, no doubt as to the correctness of my identification. The accompanying plate figure illustrates the structure of the terminal parts of the penis; it is drawn from a specimen from Singapore.

The type specimen is said to have come from Pulo Besoar in Malaya and the species ranges from the Malay Peninsula and Lower Siam through Burma and Assam to peninsular India, as far south as the Nilgiri Hills at any rate. Fraser [4] has recorded a race *krishna* from Mahableshwar in which the male has occasionally a small black spot on either side of the eighth segment of the abdomen, and sometimes a black dorsal mark on the tenth, and the female has segments 9 and

[4] Journ. Bombay Nat. Hist. Soc., 1921, p. 542.

10 blue with an occasional black mark on the base of 9. Individuals emerged from the larval state in large numbers on May 23. The specimens that I described as race *occidentalis*[5] belong to a distinct species subsequently described as *paludense* Fraser (see *occidentale*).

ACIAGRION TILLYARDI Laidlaw.

Plate 1, fig. 15.

Aciagrion tillyardi LAIDLAW, Rec. Indian Museum, vol. 16, no. 2, 1919, p. 187.
Enallagma assamica FRASER, Journ. Bombay Nat. Hist. Soc., vol. 26, 1919, p. 877.

Specimens examined.—One male (paratype) from Tura Garo Hills, Assam, 1,550 feet. One male and one female from Shillong (from Major Fraser).

This is by far the most robust of the species I have seen. The dilatation of segments 8, 9, and 10 of the abdomen is a character not found in other species of the genus.

The species appears to be confined to Assam.

I have not been able to examine the structure of the penis.

ACIAGRION OCCIDENTALE Laidlaw.

Plate 1, figs. 11 and 16.

Aciagrion hisopa (?) race *occidentalis* LAIDLAW, Rec. Indian Museum, vol. 16, no. 2, 1919, p. 187.
Aciagrion paludense FRASER, Journ. Bombay Nat. Hist. Soc., 1922, pp. 698–699.

Specimens examined.—Two males and two females from Ceylon (collection E. E. Green). One male from Cochin Strait (collection Indian Museum).

It is very unfortunate that my brief account of this form is quite incorrect. Nevertheless in accordance with the laws of nomenclature I imagine my name must take precedence over that proposed by Major Fraser.

My description states that the black mark on segment 8 of the abdomen has its apex directed toward the hinder end of the segment. This should read "directed toward the base of the segment."

The penis, like that of the next species, has the apex of the third segment cornuate and not truncate as in *hisopa*. It differs from that of *borneense* chiefly in not having the most basally situated denticles of the inner surface of this segment enlarged. Like it, it has a bilobed boss on this surface of this segment lying just basally to the denticles, whilst the lateral marginal projections are relatively larger and more apically placed.

The species is quite distinct from *hisopa* and apparently near *borneense*. It has been recorded from the Nilgiri Hills southward to Ceylon.

[5] Laidlaw, Rec. Indian Museum, vol. 16, no. 2, 1919.

"Very conspicuous though small, by reason of the bright blue color, and can easily be picked out from the more somber *hisopa* with which they mix." (Fraser.)

ACIAGRION BORNEENSE Ris.

Plate 1, figs. 10, 12, 13.

Aciagrion borneense RIS, Ann. Soc. Entomol. Belgique, vol. 55, 1911, pp. 234–235, figs. 2 and 3.

Specimens examined.—Eight males and seven females, collected by W. L. Abbott, Trong, Lower Siam (collection of the United States National Museum). I have also seen specimens from the Malay State.

This is the smallest species of the genus. The female has not been described; it is similar in coloring to the male save that segments 8 and 9 of the abdomen have a longitudinal band covering the whole of the dorsum of these segments, whilst the tenth has a basal, bilobed black mark.

The type specimen (from Borneo) is said to have the ninth segment of the abdomen entirely sky-blue. Two of the males from Trong have a small, diamond-shaped, black mark on the dorsum of this segment. I have figured one of these specimens. The anal appendages have been figured by Ris; they are very similar to those of *A. occidentale.*

The apex of the third segment of the penis is cornuate; the spur-like projections of the lateral margins are small and lie far back from the apex; the most basally situated of the denticles of the inner surface are enlarged and lie considerably more distad than the lateral projections, and between them and the projections there is a small bilobed swelling. The internal fold is small.

The species ranges from Borneo through the Malay Peninsula as far north approximately as the Isthmus of Kra.

ACIAGRION PALLIDUM de Selys.

Plate 1, figs. 1–7, 9.

Aciagrion pallidum DE SELYS, Ann. Mus. Civico di Genova, vol. 30, 1891, pp. 80–81 (separate).—LAIDLAW, Rec. Indian Museum, vol. 16, no. 2, 1919.

Specimens examined.—Very numerous females and males from Lower Burma, collected by R. A. Earnshaw, in Mr. Williamson's collection. I have seen also specimens from Assam and from peninsular India from the north Kanara District and Nagpur.

As the species is structurally a typical member of the genus I have figured certain details of venation, etc., in some detail. In color-

ing *pallidum* is possibly more specialized than other *Aciagrion* (except perhaps *olympicum*). At any rate it departs more widely in this respect than do most of its congeners from the usual *Enallagma* pattern. Young specimens are curiously suggestive of *Amphicnemis*, though there is, I believe, no close relationship.

As in *hisopa* the penis has the apex of the third segment truncate and without cornua. It differs from *hisopa* in that the most basally situated denticles are much enlarged and project backward like barbs between the two large, lateral marginal spurs.

ACIAGRION OLYMPICUM Laidlaw.

Plate 1, fig. 14.

Aciagrion olympicum LAIDLAW, Rec. Indian Museum, vol. 16, no. 2, 1919, pp. 184–186.

Specimens examined.—One male (paratype) from Darjiling District.

This is the largest species of the genus so far as I know. Its markings are on the whole similar to those of the most of the species of the genus, save perhaps that in the male the marking on the dorsum of the second segment of the abdomen is reduced to a pentagonal or triangular spot. The coloring is however remarkable in that blue is altogether absent, and that the ground color is a fawn or buff. I have not been able to examine the penis. The anal appendages of the male as already noted are similar in plan to those of some of the African species of *Africallagma* figured by Doctor Ris.

A. olympicum has been recorded only from the foothills of the Himalaya, near Darjiling.

The following are the references to the three species I have not had an opportunity of examining.

ACIAGRION APPROXIMANS (de Selys).

Pseudagrion microcephalum (?) race *approximans* DE SELYS, Bull. Acad. Belgique, ser. 2, vol. 42, 1876, pp. 507–508.

Aciagrion approximans DE SELYS, Ann. Mus. Civico di Genova, vol. 30, 1891, p. 80.

ACIAGRION FRAGILIS (Tillyard).

Ischnura (?) *fragilis* TILLYARD, Proc. Linn. Soc. New South Wales, 1906, pt. 2, pp. 186–187, pl. 17, fig. 6.

Aciagrion fragilis TILLYARD, Proc. Linn. Soc. New South Wales, vol. 37, pt. 3, 1912, p. 472, pl. 46, figs. 21, 22; pl. 49, fig. 22.

ACIAGRION AZUREUM Fraser.

Aciagrion azureum FRASER, Mem. Dept. Agr. in India, vol. 7, no. 7, 1922, p. 51.

EXPLANATION OF PLATE.

(All figures drawn by the author.)

FIG. 1. Forewing of male *Aciagrion pallidum* from collection of E. B. Williamson.

2. Detail of base of forewing of *Aciagrion pallidum*.
3. Detail of base of hind wing of *Aciagrion pallidum*.
4. Apex of abdomen of male *Aciagrion pallidum*, from the side.
5. Apex of abdomen of female *Aciagrion pallidum*, from the side.
6. Pterostigma of hind wing of *Aciagrion pallidum*.
7. Pterostigma of forewing of *Aciagrion pallidum*.
8. Terminal parts of penis of *Aciagrion hisopa*.
9. Terminal parts of penis of *Aciagrion pallidum*, seen obliquely from the side.
10. Apex of abdomen of male *Aciagrion borneense*, seen from above.
11. End-on view of tenth segment of abdomen of *Aciagrion occidentale*.
12. Terminal parts of penis (slightly diagrammatic) of *Aciagrion borneense*.
13. Apex of abdomen of female *Aciagrion borneense*, from above.
14. Anal appendages of male *Aciagrion olympicum*, from the side and a little ventrally.
15. Apex of abdomen of *Aciagrion tillyardi*, seen from side.
16. Apex of abdomen of male *Aciagrion occidentale*, seen from above.

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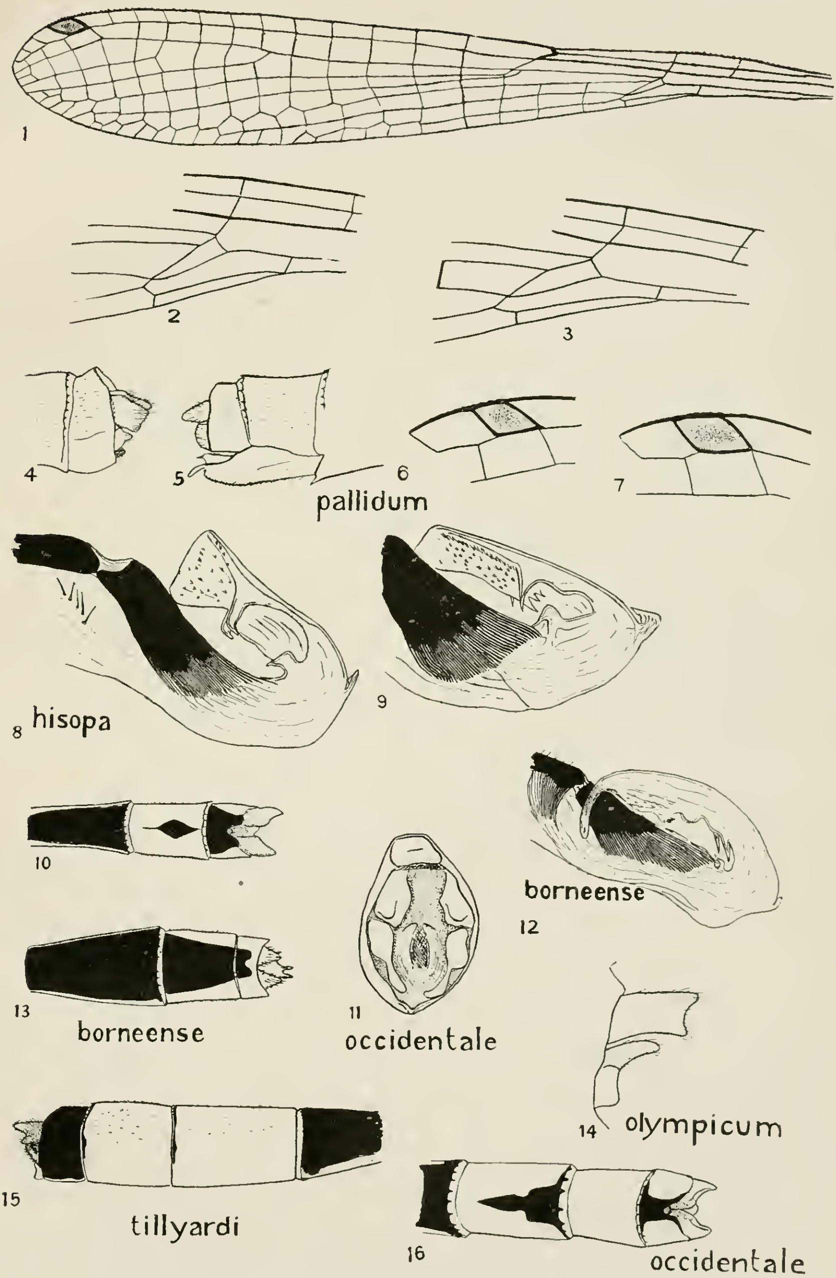

DETAILS OF DRAGONFLIES OF THE GENUS ACIAGRION

FOR EXPLANATION OF PLATE SEE PAGE 9

A NEW SPECIES OF ROUND WORM OF THE GENUS TRICHOSTRONGYLUS FROM THE RABBIT

By H. W. Graybill

Of the Rockefeller Institute for Medical Research

In making autopsies on two wild rabbits of Princeton, N. J., an apparently undescribed species of *Trichostrongylus* was found in the large intestine of one. In addition to this nematode, it will be of interest to note that both rabbits were infested with *Obeliscus cuniculi*, a new genus of nematode which the writer described from the domestic rabbit [1] and with *Trichostrongylus calcaratus* Ransom, 1911. The latter species has also been collected here from one of our domestic rabbits kept for experimental purposes.

So far as the writer has been able to determine, three species of *Trichostrongylus* have been described from rabbits: *T. retortaeformis* (Zeder, 1800) Loos, 1905; *T. pigmentatus* (von Linstow, 1904) Hall, 1916; and *T. calcaratus* Ransom, 1911.

TRICHOSTRONGYLUS AFFINIS, new species

Male.—The maximum width of the body occurs at the base of the bursa. From there it tapers uniformly to the anterior end. Length 5–7.5 mm.. maximum width 123μ, width of head 12μ. The anterior end is rounded. The esophagus is broadest near the posterior end and tapers gradually anteriorly. Its length is 562–787μ, maximum width 27μ, and the nerve ring 127μ from the anterior end.

The lateral lobes of the bursa are rolled inward in preserved specimens, making it very difficult to observe the shape and arrangement of the rays. A dorsal lobe has not been observed. The ventro-ventral and externo-dorsal rays at their distal ends curve ventrally and dorsally, respectively (fig. 1). The other rays lie close together. The externo-lateral ray is very broad, the latero-ventral ray is not so broad, and the postero- and medio-lateral rays are relatively narrow. The dorsal ray divides distally into two short branches. The spicules and gubernaculum are brown in color. The spicules are about equal, short, stout, curved ventrally, and at the proximal

[1] Parasitology, vol. 15, No. 3, p. 340, 1923.

end are provided with a thin, rounded, projecting appendage, concave on its anterior face (fig. 2). They taper somewhat, and at the distal end are provided with two rather blunt, recurved hooks on the ventral side. In the left spicule one hook is larger and forms the end of the spicule and the other is located just a very little anterior and to one side. The right spicule is likewise terminated by a hook, which is the smaller, and the other is located considerably further forward. Length of spicules 131–156μ, maximum width 29μ. The gubernaculum (figs. 1 and 2) is roughly boat-shaped when seen from the dorsal aspect, but from the side it consists of a roughly triangular body with a narrow, curved, slightly tapering process extending anteriorly from the antero-dorsal angle; length 74–86μ, width 21–33μ.

Female.—The maximum width is in the posterior region of the body. Anteriorly the body tapers gradually to a thin filament, posteriorly to a fine point (fig. 3). Anterior end rounded. Length 8.7–9.25 mm., maximum width 106–177μ, width of head 16μ. Anus 141–164μ from posterior end, vulva 1.6–1.7 mm. from posterior end. Oesophagus same shape as in male. Length 816–955μ, maximum with 37μ, nerve ring 131μ from anterior end.

The vulva is a crescentic slit lying apparently in a lateral (left) instead of a ventral position with the long axis directed longitudinally. Well-developed ovijectors are present (fig. 4).

Ova present in the ovijectors were studied. They are ellipsoidal, surrounded by a very thin shell, and are in process of segmenting, the cell mass filling the entire space within the egg. Size 57–66μ long by 33–40μ broad.

The type specimen has been deposited in the Helminthological Collections of the U. S. National Museum, where it is registered as No. 7804. Paratypes are also included and are entered as 7805.

This species resembles somewhat *T. retortaeformis*, but differs in the size and shape of the spicules and gubernaculum, size of the eggs, and various other characters.

EXPLANATION OF PLATE.

Trichostrongylus affinis, new species

All drawings made with a camera lucida.

FIG. 1. Dorso-lateral view of bursa showing dorsal ray, left externo-dorsal ray, and all six rays in right lobe of bursa. Spicules and gubernaculum shaded × 345.

2. Spicules and gubernaculum × 345.

3. Posterior end of female × 395.

4. Ovijectors of female, vulva not shown, × 170.

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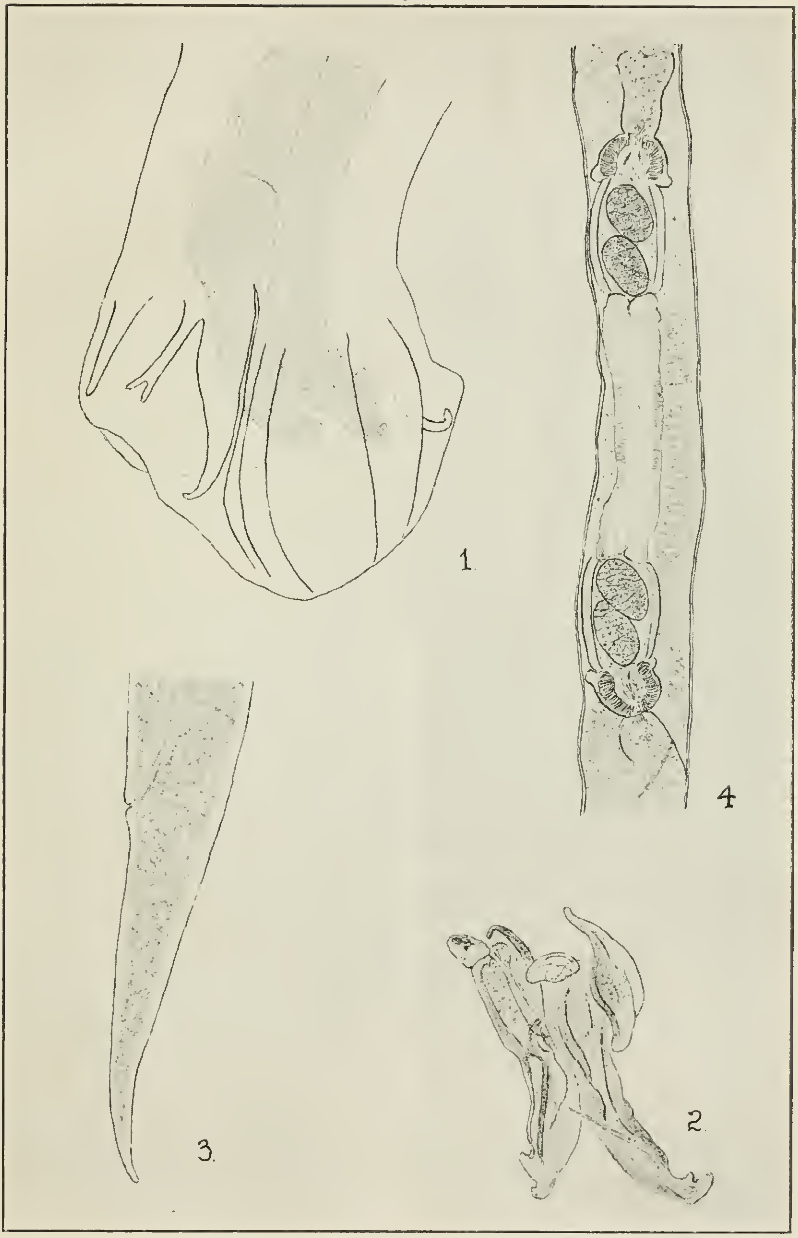

TRICHOSTRONGYLUS AFFINIS, NEW SPECIES

FOR EXPLANATION OF PLATE SEE PAGE 2

A NEW EARTHWORM FROM TEXAS BELONGING TO THE GENUS DIPLOCARDIA.

By Frank Smith,

Of the University of Illinois, Urbana.

The genus *Diplocardia* includes a considerable number of species already described, and presumably an even larger number yet to be made known. They constitute a group of indigenous species, apparently limited to North America, which exhibit an unusual range of variation in the position of the spermiducal pores. The ordinary position of these pores in the nearly related groups is on the eighteenth somite. In the majority of species of *Diplocardia* they are on the nineteenth somite; in one species, at least, they are on somite 20; and in still another one, *D. keyesi*, they are on somite 21. This last-named species was based on one specimen obtained by Eisen in Lower California and originally described (Eisen, 1896) under the name *Aleodrilus keyesi.*

The writer recently received from Dr. C. V. Piper of the Bureau of Plant Industry at Washington, D. C., two specimens of a closely allied form, which had been collected in Texas, and which represent a variety of *D. keyesi.* As a matter of convenience in making comparisons, a brief summary of the distinguishing characters of the type form of the species from a later paper of Eisen (1900) will be first presented; this will be followed by a similar summary of important characters of the new variety; and then a more extended description and comparison will be undertaken.

This paper forms No. 245 of the series of contributions from the zoological laboratory of the University of Illinois.

DIPLOCARDIA (ALEODRILUS) KEYESI (Eisen).

Definition.—Color, flesh, marbled violet, no pigment. Size, 70 mm. by 5 mm. Somites 150. Prostomium divides somite I about one-half. Dorsal pores, the most anterior one, VIII/IX. Spermiducal pores in XXI. Spermathecal pores, two pairs, in VIII and IX, in front of setae *ab*. Prostate pores in XX and XXII. Oviducal pores

in front of setae *a*. Setae all ventral; *a-b* slightly larger than *c-d*; *a-a* larger than *b-c*. No sculpture. Penial setae, none. Spermathecal setae not differentiated. Clitellum ringlike anteriorly, posteriorly saddle shaped. Genital zone not distinct; two parallel grooves in $\frac{1}{2}$ XX–$\frac{1}{2}$ XXII; groove almost straight, with a knob at each apex; concavity turned ventrally. Esophagus without calcic concretions. Gizzards in V and VI. Sacculated intestine in XV. Dorsal vessel single, not covered with chloragogen cells. Hearts in X, XI, XII with large pulsating divisions; no chloragogen cells. Nephridia, meganephridia, no coelomic mantle. Testes in X and XI. Sperm-funnels in X and XI. Sperm-ducts, which join at XII/XIII in a common muscular sheath; fuse in XX/XXI. Sperm-sacs, one pair preseptal in IX, one pair postseptal in XII. Sperm-masses in X and XI. Oviducts in XIV. Prostates confined to one somite each; small, tubular, thicker at apex. Spermathecae, two pairs in VIII and IX; distal end knoblike; the duct is very slender and long, with a minute wartlike and ear-shaped diverticle situated about the middle.

Septal formula.—

$$\overline{\text{VI/VII}},\ \overline{\overline{\overline{\text{VII/VIII}}}},\ \overline{\overline{\overline{\text{VIII/IX}}}},\ \overline{\overline{\text{IX/X}}},\ \overline{\text{X/XI}}$$

DIPLOCARDIA KEYESI TEXENSIS, new variety.

Length, 80 mm. Diameter (maximum), slightly less than 2 mm. Somites, 139–146. Color, pale; no obvious pigment. Clitellum, 13–20; thin on midventral strip. Genital papillae, transverse band between oviducal pores. Setae, anteriorly, $aa:ab:bc:cd=7:2:6:2\frac{1}{2}$; near somite $25=6:2:6:2$; ventral setae absent on 21 and slightly modified on 20 and 22. Dorsal pore, most anterior, 9/10 or 10/11. Nephridiopores, dorsad of setae *d*; first in 2. Spermiducal pores, $\frac{1}{4}$ 21; in seta line *b*. Prostate gland pores, 20 and 22; with ventral setae. Oviducal pores, anterior part 14; slightly mesad of seta line *a*. Spermathecal pores, near anterior margins 8 and 9; nearly in seta line *a*. Septa, 7/8 and 8/9 strongly thickened; 6/7 and 9/10 less strongly thickened. Gizzards in 5 and 6. Expanded intestine, begins in 19. Dorsal vessel single. Hearts, dorso-intestinal in 10–12; dorsal hearts in 7–9. Nephridia, paired; first in 2. Spermaries and spermiducal funnels, paired in 10 and 11. Sperm ducts of either side fuse in 21 near their openings. Prostate glands, paired in 20 and 22. Sperm sacs, paired in 9 and 12. Ovaries and oviducal funnels, paired in 13. Ovisacs, paired in 14. Spermathecae, paired in 8 and 9; small diverticula attached at junction of ducts and sacs.

Two specimens collected at Chillicothe, Texas, in Bermuda grass sod.

Holotype.—Cat. No. 19116, U.S.N.M. *Paratype.*—In collection of the writer.

Sagittal sections were made of one-half of the anterior 24 somites of the specimen having the clitellum best developed, and this specimen was used as the type of the new variety. Transverse sections were made of the anterior 25 somites of the other specimen which is designated as the paratype. The general condition of the reproductive organs of both worms indicate that they had passed the climax of a state of sexual activity and that the reproductive organs are not at a stage of maximum development. The new form agrees in several important characters with *Diplocardia keyesi*, described by Eisen (1896) from a specimen collected in Lower California. Since there is agreement between the new form and Eisen's species in most characters which usually serve as a basis for distinguishing between species in this genus, it seems preferable to treat the new form as a variety of the species mentioned.

Eisen's original description included many details concerning some of the organs and was accompanied by numerous illustrations. The same species was later described more briefly (Eisen 1899) in a paper which dealt in a preliminary way with all of the species of *Diplocardia* known at the time, and which included descriptions of some new species of that genus. In the following year Eisen (1900) published a more extensive paper which contained descriptions of the known species of *Diplocardia* and of still another new species. There are several discrepancies between some of the statements made in the original description of *D. keyesi* and those made in the two later papers. Although no statement with reference to it is made in either of the later papers, it is probable that some of the changes were intended to correct errors made in the original description. In other instances it is by no means clear which of the differing statements is more nearly correct.

EXTERNAL CHARACTERS.

The two Texas worms are similar in size, about 80 mm. in length, and have a maximum diameter of slightly less than 2 mm. The type specimen has 139 somites and the paratype 146. (Eisen's specimen is stated in all three papers to be 70 mm. by 5 mm. Figure 66 of his first paper is described as of natural size, and is about 85 by 3 mm. In the first paper the number of somites is given as 80 and in the other two papers as 150.) The worms preserved in alcohol are pale and without obvious pigment in the body wall. The formula $aa:ab:bc:cd=7:2:6:2\frac{1}{2}$ indicates the relative setal distances of a considerable number of anterior somites and is based on averages of several measurements. In the vicinity of somite 25 the formula $aa:ab:bc:cd=6:2:6:2$ is more nearly accurate. (A similar formula

based on Eisen's first paper would be $aa:ab:bc:cd=7:3:6:4$. In his last two papers he writes "*a–b* slightly larger than *c–d*.") Ventral setae are lacking on 21; and those of 20 and 22, related to the prostate gland pores, differ but slightly from those of other somites, being somewhat straighter. The ventral setae of the spermathecal somites are not modified in character, as are those of several other species of the genus. Similar statements are made by Eisen concerning *D. keyesi*.

The clitellum on the dorsal side includes all of 13–20 and a part of 12. Ventrally it extends from ⅓13–½20, but thins out on a narrow median strip. A transverse glandular thickening extends across this median area between the oviducal pores. Eisen describes and figures two longitudinal grooves connecting the prostate gland pores of the corresponding sides. No such grooves are present in the specimens of the new form, but the absence is probably due to the sexually nonactive condition. Such grooves are present at the time of sexual activity in most known species of the genus. The first dorsal pore is at the anterior margin of 10 in the type, and in 11 of the paratype. The nephridiopores are near the anterior margins of the somites. Those of the most anterior pair are in the second somite and are dorsad of seta line *d* by a distance at least twice as great as *cd*, the distance between the setae of the dorsal bundle. Several of those in the clitellar somites are dorsad of seta line *d* by a distance nearly as great as *cd*, or even greater. The majority of those of the anterior 25 somites are but slightly dorsad of seta line *d*. The nephridiopores of somites posterior to 25 have not been studied. The spermiducal pores are on the ventral side of 21; are scarcely one-fourth of the length of the somite from the anterior margin; and are nearly in seta line *b*. The prostate gland pores are in close relation to seta *b* of somites 20 and 22. Eisen describes and figures the spermiducal pores of *D. keyesi* as opening midway of the length of 21 and midway between the corresponding prostate gland pores. In the new variety the distance from the spermiducal pore to the anterior gland pore of the same side is scarcely one-half as great as that to the posterior pore. The oviducal pores are on the anterior part of 14 and slightly mesad of seta line *a*. The spermathecal pores are near the anterior margins of 8 and 9 and nearly in seta line *a*.

INTERNAL CHARACTERS.

Septa 7/8 and 8/9 are most strongly developed and are about as thick as the body wall. Septa 6/7 and 9/10 are also thickened, but not as much as the two first mentioned. Septum 5/6 is normally developed and extends to the body wall, and so also does an extremely thin but perfectly evident septum 4/5 which is the most anterior

one. In *D. keyesi* Eisen describes 7/8, 8/9, and 9/10 as much thicker than the body wall; 5/6 is said to not join the body wall, but is described and figured as forming a sort of sac including the pharyngeal region of the esophagus. He found no trace of a septum anterior to 5/6.

Two well-developed gizzards are present in 5 and 6. The pharyngeal region and the esophagus as far back as 13 are not noticeably different from those of other species. The walls have an extensive blood supply in 9–13 through numerous branches of the supra-intestinal vessel. The walls of 14 and 15 are also highly vascular. They have several connections with the dorsal vessel and have a few low longitudinal folds of the epithelial layer. In the type specimen there is a considerable dilation of these two somites, but not in the paratype. The contracted part of the esophagus beginning with 16 has no such extensive blood supply as has the part anterior to it, and has a diameter only about one-third as great as that in 19, where the expanded intestine begins. The walls of the latter have an extensive blood supply. Eisen makes no reference to the place of the beginning of the widened intestinal part in his original description of *D. keyesi*, but a figure in that paper conforms with the brief statement in each of the two later papers—"sacculated intestine in XV." Eisen states that no typhlosole is present in that species, but the new form has one that is perfectly obvious.

The dorsal and supra-intestinal vessels in a few somites of the type specimen are not included in the piece that was sectioned, but there is nothing to indicate that the character and relations of these vessels and of the hearts in the type specimen differs from those found in the paratype. The dorsal vessel has not been found to be double in any part of its course. The supra-intestinal vessel is a definite, distinct trunk from the middle of the ninth to the middle of the thirteenth somite. The "hearts" of 10 to 12 are much larger than the others, and are of the dorso-intestinal type, regularly found in the genus, while those of 7 to 9 are of the dorsal type. In his description of *D. keyesi*, Eisen writes simply of vessels in 7–12 connecting the dorsal and ventral vessels, and states that those of 10, 11, and 12 are larger and of "the form of so-called hearts." At the time that he wrote it had not been noticed that the posterior pairs of hearts in *Diplocardia* are of the dorso-intestinal type.

The nephridia are meganephric and the first pair is in the second somite. The nephridial ducts with nephridiopores, but slightly dorsad of seta line *d* have a course which is slightly ventrad and posteriad through the layer of circular muscle fibers in the body wall to a level of seta line *d*, and then through the layer of longitudinal muscle fibers to the coelome. Their course in this latter layer is between the two bands of fibers which further posteriad separate and extend on

either side of the *d* setae. The ducts of the second somite and of the clitellar somites which have the more dorsally placed nephridiopores pass through the longitudinal muscle layer at a level considerably dorsad of seta line *d*.

The reproductive organs in most respects are similar to those already known in the genus. Paired spermaries and spermiducal funnels have the usual positions and relations in 10 and 11. The sperm ducts of either side are in close proximity in their course posteriad, but fusion into one duct does not take place until they have reached 21, on which they open to the exterior. The prostate glands are paired in 20 and 22, a position known heretofore only in *D. keyesi*. The glands are relatively small and each occupies but a small space in one somite. The duct is rather short and the lumen is very definite. It has a diameter ¼ to ⅓ as great as that of the gland itself. Sperm sacs are paired in 9 and 12. Ovaries and oviducal funnels are paired in 13, and the paired oviducts have a fairly direct course to their outlets on the next following somite. A pair of ovisacs in 14 have their communications with 13 through openings dorsad of the oviducal funnels and near the esophagus. Paired spermathecae in each of somites 8 and 9 are of relatively small size, due in part to the fact that the worms were not sexually active when collected. Minute diverticula are attached at the junction of the short sacs with the ducts. In *D. keyesi* the ducts are relatively much longer and the diverticula are attached to them approximately midway of their length. Eisen (1900, fig. 136) figures the length of the duct as about three times that of the sac, while in the new form the lengths of the duct and of the sac are approximately equal.

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NEW SPECIES OF MOLLUSKS OF THE GENUS CHILINA.

By William B. Marshall,
Assistant Curator, Division of Mollusks, United States National Museum.

Of the species herein described as new, four were received from Mrs. T. S. Oldroyd, of Stanford University. Three of them come from obscure lakes and rivers in the Andes along the border between Chile and Argentina. The fourth comes from Southern Chile, with no more specific locality given. One new species from Lake Nahuel Huapi in the Andes in the Province of Rio Negros, Argentina, and a new subspecies of *Chilina parchappii* Orbigny from Mar del Plata, Argentina, were received from Dr. Florentino Felippone of Montevideo, Uruguay. A new species, from the stomach of a bird on Lake Wafrel, Chile, has lain for many years without identification in the Museum collection.

CHILINA AURANTIA, new species.

Plate 1, fig. 6.

Shell elongate-ovoid, rather solid, smooth and slightly glossy, the satures obscurely margined. Last whorl very large; aperture very wide. Surface closely spirally striated, the last whorl malleated behind the aperture. Aperture flaring, outer lip simple; columella white, not very wide, flattened and a little twisted, and bearing a white twisted tooth on the inner side of its upper end; parietal wall entirely covered with a white callus, and bearing a linear rudimentary tooth on its middle portion. Color bright orange yellow with four ashy spiral bands which show also within the aperture.

The type, Cat. No. 360163, U.S.N.M., measures: Length, 20 mm.; diameter, 12 mm.; length of aperture, 15 mm. It is from the stomach of a "pejerey bird," taken on Lake Wafrel, Chile, December 31, 1903. Cat. No. 226315, U.S.N.M., includes 14 other specimens taken from the same bird.

This species is very similar to that described in this paper under the name of *Chilina castanea*, but differs in the color, the greater

size, and especially in the numerous spiral striae. The two may, however, be but variations of the same species. It is hardly possible to tell to just what extent the process of digestion in the bird's stomach has affected the color of the shells. That digestion had not progressed very far is indicated by the generally fine condition of the periostracum and the clear, clean, enamel-like appearance of the white columella and callus.

CHILINA CASTANEA, new species.

Plate 1, fig. 5.

Shell ovoid, moderately thin; suture very narrowly channeled; entire surface of the shell obscurely, spirally striated, the striae more pronounced just below the suture; axial growth lines numerous, varying from fine striae to rather coarse riblets; last whorl malleated, especially behind the outer lip. General color a rich, glossy chestnut, with several faint spiral bands made up of arrow-head markings of darker color. The aperture is about three-fourths of the length the shell would have were not a small portion of the apex eroded. Columella not very broad, its edges slightly arcuate, and bearing a moderately strong, transverse tooth on the inner edge of its upper end. Parietal wall covered with a callus and bearing a small transverse tooth at its middle portion. Columella and teeth white. Outer lip simple, slightly sinuous. Interior of aperture whitish with a livid cast and with four fairly distinct spiral bands of purplish color.

The type, Cat. No. 359911, U.S.N.M., measures: Length, 18.5 mm.; diameter, 11.5 mm.; length of aperture, 14 mm. It and two other specimens, Cat. No. 359912, U.S.N.M., come from Rio Corcovado, Province of Chubut, Argentina, and were received from Mrs. T. S. Oldroyd. The label with the specimens states that this river is in the Pacific drainage. Three other specimens from the same locality were returned to Mrs. Oldroyd.

The rich glossy chestnut color serves to distinguish this species.

CHILINA PARCHAPPII MINOR, new subspecies.

Plate 1, fig. 7.

Similar to the typical species except that it is smaller, the tooth is very small, and within the aperture there are four interrupted purplish revolving bands corresponding to similar bands on the exterior.

The type, Cat. No. 360164, U.S.N.M., measures: Length, 18 mm.; diameter, 9 mm.; length of aperture, 12 mm. It comes from the Mar del Plata, Argentina. Cat. No. 348256, U.S.N.M., includes three

other specimens from the same place. All were presented by Dr. Florentino Felippone, of Montevideo, Uruguay. All four specimens are remarkably uniform in all respects.

CHILINA FLAMMULINA, new species.

Plate 1, fig. 4.

Shell thin, elongate, somewhat oliviform; sutures minutely margined and edged with whitish; whorls but slightly rounded, body whorl very long, rather narrow; spiral striae lacking; axial sculpture of regularly spaced growth lines, so fine and close as to resemble striae. Aperture long and narrow, its outer lip simple, slightly advanced at the middle portion. Columella white, narrow, a little flattened obliquely and with a slight twist and bearing a moderate tooth on the inner edge of its upper portion, the tooth almost invisible in a full front view of the shell. Parietal wall covered with a white callus. Color yellowish with an olive tinge, much flamed with vertical waved stripes of reddish chestnut; interior of aperture brownish, the flammulations of the exterior showing through the shell.

The type, Cat. No. 359913, U.S.N.M., measures: Length, 14.25 mm.; diameter, 8 mm.; length of aperture, 10 mm. It comes from Rio Fitaleufa, Province of Chubut, Argentina, a stream in the Pacific drainage. Cat. No. 359914, U.S.N.M., includes three other specimens from the same place. All were received from Mrs. T. S. Oldroyd, and five specimens from the same locality were returned to her.

CHILINA FELIPPONEI, new species.

Plate 1, fig. 2.

Shell small, globose, smooth, glossy; sutures slightly channeled, body whorl inflated; surface obscurely spirally striated; back of body whorl somewhat malleated; axial sculpture of a few low growth lines; aperture very large, white within, outer lip simple, nearly circularly rounded; columella white, flattened and slightly excavated and with a moderate, slightly oblique tooth near its upper end; parietal wall with a narrow band of white callus at its lower part; its upper portion like the exterior of the shell. Color brownish olive with zigzag reddish vertical lines, each of which becomes broader at intervals to help form four spiral bands. Apical whorls lost.

The type, Cat. No. 360165, U.S.N.M., measures: Length, 10 mm.; diameter, 7.5 mm.; length of aperture, 9 mm. It comes from Lake Nahuel Huapi in the Andes of Western Rio Negro Province, Argentina. Cat. No. 360166, U.S.N.M., includes another specimen from the same place. Both were received from Dr. Florentino Felippone.

This is one of the smallest species yet recorded for this genus. Its nearest ally is *C. olivacea*, described in this paper.

CHILINA OLDROYDAE, new species.

Plate 1, figs. 1, 3, 8, 10.

Shell elongate, acuminate, thin, translucent, consisting of about seven whorls (apical whorl eroded). Whorls slightly convex, body whorl somewhat constricted behind the outer lip; suture minutely margined; surface with numerous axial striae and slight plicae of growth, and obscurely spirally striated, the striae more prominent at the lower part of the last whorl; a number of fine incised spiral lines and a few broken or continuous incised lines here and there over the whole body whorl. Aperture ear-shaped, occupying about half the length of the shell, its outer lip thin and slightly sinuous. Columella broadly flattened, slightly excavated, its edges somewhat arcuate, and bearing at its upper inner end a prominent oblique fold. Color, pale yellowish olive; body whorl with a band of arrow-head markings of chestnut near the suture, a similar band encircling the base, and two faint broad bands on the middle portion of the whorl. On the penultimate whorl all the bands are concealed by the body whorl, except one band of arrow-head markings near the middle of the whorl. Earlier whorls pale. Columella and parietal callus white, interior of shell whitish tending to livid flesh color.

The type, Cat. No. 359906, U.S.N.M., measures: length, 42 mm.; diameter, 19 mm.; length of aperture, 22.5 mm. It comes from Lake Fetalafquen, in the Andes, in the northwestern part of the Province of Chubut, Argentina, and was received from Mrs. T. S. Oldroyd.

In a general way this shell in form and size recalls the well-known *Lymnaea stagnalis* Linnaeus. Its nearest relatives are *Chilina fulgurata hatcheri* Pilsbry and *C. smithi* Pilsbry. Its size and locality at once separate it from the former, while its thin texture, color, and locality distinguish it from the latter.

Like *C. smithi*, this species varies much in form and size. Its coloration in the eight specimens at hand is fairly uniform except in the varying intensity of the color bands. Five of the specimens are more chunky (for example one has a length of 30 mm. and a diameter of 16½ mm.). All the color bands on these show a more or less strongly marked tendency to have all four of the color bands made up of arrowheads. One specimen, typical in form, has the whole surface covered with zigzag lines of reddish, with accentuated arrowhead spots to form the four color bands. One specimen is so distinctly shouldered that it is turrited.

CHILINA OLIVACEA, new species.

Plate 1, fig. 9.

Shell ovoid, moderately solid, smooth, unctuous, distinctly slopingly shouldered, upper whorls angulated, sutures distinctly margined,

surface obscurely spirally striated, the striae more distinct on and above the shoulder and on the lower portion of the body whorl; axial sculpture consisting of low lines of growth hardly visible to the unaided eye. Apex eroded, whorls apparently about five, the body whorl very large. Aperture slightly flared, wide and high, about three fourths as long as the shell. Outer lip simple, angled at the shoulder. Columella white, flattened, slightly arcuate, with a moderately thick tooth near its upper end resembling the thread of a stout screw. Half the height of the parietal wall covered with a thick white callus, the upper portion of the parietal wall like the outer surface of the shell. Interior of aperture pinkish white with four broad dark bands. Color of shell light olive greenish with numerous zigzag axial stripes of chestnut which, on the body whorl, are emphasized to form four spiral bands.

The type, Cat. No. 359908, U.S.N.M., measures: Length, 20 mm.; diameter, 12.5 mm.; length of aperture, 15 mm. It comes from Southern Chile and was received from Mrs. T. S. Oldroyd. Cat. No. 359909, U.S.N.M., includes two other specimens from the same lot, and three others were returned to Mrs. Oldroyd.

This species is characterized by the smooth, olivaceous periostracum and the beautiful zigzag coloration emphasized into four bands on the body whorl. Its nearest relative is *Chilina fluctuosa* Gray.

EXPLANATION OF PLATE.

All figures × 1½,

FIG. 1. *Chilina oldroydae*, new species.
2. *Chilina felipponei*, new species, type.
3. *Chilina oldroydae*, new species,
4. *Chilina flammulina*, new species, type.
5. *Chilina castanea*, new species, type.
6. *Chilina aurantia*, new species, type.
7. *Chilina parchappii minor*, new subspecies, type.
8. *Chilina oldroydae*, new species.
9. *Chilina olivacea*, new species, type.
10 *Chilina oldroydae*, new species, type.

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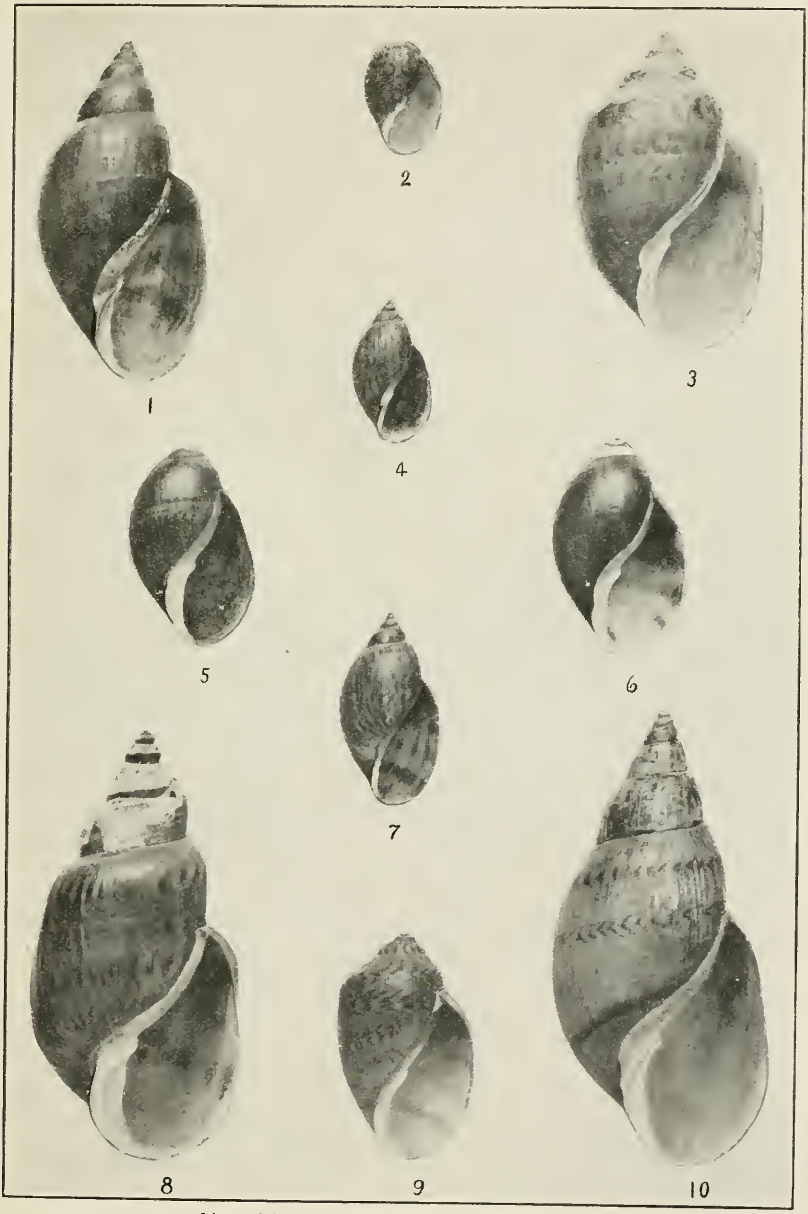

NEW MOLLUSKS OF THE GENUS CHILINA

FOR EXPLANATION OF PLATE SEE PAGE 5

NEW MOLLUSKS FROM SANTA ELENA BAY, ECUADOR.

By Paul Bartsch.

Curator of Mollusks, United States National Museum.

Dr. R. A. Olsson has recently submitted to the United States National Museum a small lot of Pyramidellidae and Melanellidae collected by him in Santa Elena Bay, Ecuador. This is the first material that we have had from this locality. In fact, very little has been collected excepting the gathering made during the forties of the last century at this place by Hugh Cuming, which did not stress the minute species.

A very careful comparison of these specimens with the magnificent Panama series in the United States National Museum reveals the fact that every species represented in this gathering proves to be undescribed. This should certainly stimulate future efforts in this region, as well as in the territory to the south of it, from which very little minute material has come to hand.

All the species described in this paper are based upon Doctor Olsson's collecting at Santa Elena Bay. The specimens have been donated to the United States National Museum.

PYRAMIDELLA (LONGCHAEUS) ELENENSIS, new species.

Plate 1, fig. 5.

Shell elongate-conic, pinkish white, with a lighter median zone on each whorl. Nuclear whorls decollated. Postnuclear whorls flattened, narrowly tabulatedly shouldered at the summit, which is also minutely crenulated. Periphery of the whorls marked by a slender incised groove, crossed by numerous minute riblets and bounded posteriorly by a rather strong keel. The summit of the succeeding whorls falls below the groove and causes the suture to appear deeply channeled and finely denticulated. Base short, well rounded, smooth. Aperture fractured in both of our specimens; outer lip provided with four conspicuous spinal laminæ within, of which two are posterior and two anterior to the peripheral sulcus. Columella short, very stout, provided with a very broad lamellar fold about one-third of the distance from its insertion to the tip anterior to the insertion,

and two additional folds which are much weaker, the anterior one being the weaker.

The type, Cat. No. 359747, U.S.N.M., has lost the nuclear whorl and probably the first two and a half postnuclear turns. The 7.5 remaining measure: Length, 6.4 mm.; diameter, 2.5 mm. Cat. No. 359748, U.S.N.M., contains another specimen from the same locality.

This species suggests in size *Pyramidella* (*Pharidella*) *panamensis* Dall and Bartsch, but it is distinguished from this at once by its much broader whorls and less deep sutural channels, and absence of the axial riblets.

TURBONILLA (CHEMNITZIA) THEONE, new species.

Plate 1, fig. 6.

Shell short, stout, elongate-conic. Nuclear whorls decollated. Postnuclear whorls slightly rounded, narrowly slopingly shouldered at the summit, marked by broad, strongly protractively curved axial ribs, of which 16 occur upon the second, 18 upon the third, 20 upon the fourth, 22 upon the fifth, 24 upon the sixth, 26 upon the seventh and the last whorl. These ribs render the summit of the whorls feebly crenulated. The intercoastal spaces are a little less wide than the ribs, and only feebly impressed, terminating at the periphery. Base rather long, strongly rounded. Aperture oval; posterior angle obtuse; outer lip fractured; inner lip reflected and appressed to the base for two-thirds of its length, provided with a feeble oblique fold a little anterior to its insertion; parietal wall covered by a thin callus.

The type, Cat. No. 359756, U.S.N.M., has lost the nucleus. The 7.5 whorls remaining measure: Length, 4.9 mm. diameter, 1.7 mm. Cat. No. 359757, U.S.N.M., contains another specimen from the type locality.

This species differs from all the other members of the West coast by its almost elongate oval outline and stout shape.

TURBONILLA (CHEMNITZIA OENOA, new species.

Plate 1, fig. 3.

Shell small, subdiaphanous, yellowish white, with a bluish band at the summit of the whorls where this is appressed to the preceding turn. This band gives the shell the appearance of being ornamented by a string of beads at this place. Nuclear whorls decollated. Postnuclear whorls slightly rounded, rather strongly obliquely tabulatedly shouldered at the summit, crossed by slightly protractive ribs, which render the summit crenulated, and which are about as wide as the spaces that separate them. Of these ribs, 16 occur upon the first and second, 18 upon the third, 20 upon the fourth, 22 upon

the fifth and sixth, 24 upon the seventh, and 28 upon the last turn. Intercostal spaces moderately, deeply impressed, terminating at the periphery, which is well rounded. Base moderately long, well rounded, marked by lines of growth only. Aperture oval; posterior angle acute; outer lip thin, showing the external sculpture within; inner lip slightly sinuous, reflected over and appressed to the base, for almost its entire length, provided with a feeble, oblique fold at its insertion.

The type, Cat. No. 359753, U.S.N.M., has 8.5 whorls and measures: Length, 4.2 mm.; diameter, 1.3 mm. Cat. No. 359754, U.S.N.M., contains two additional specimens from the same locality.

The present species is nearest related to *Turbonilla* (*Chemnitzia*) *kelseyi* Dall and Bartsch, but differs from it by its much more elegant features, strongly tabulated shoulder, with the crenulations at the termination of the ribs at the summit forming a more conspicuous beaded pattern.

TURBONILLA (TURBONILLA) AXELI, new species.

Plate 1, fig. 1.

Shell small, elongate-conic, bluish white. Nuclear whorls two and a half, smooth, forming a decidedly elevated spire which has its axis at right angles to that of the succeeding whorls, in the first of which the nuclear spire is about one-fourth immersed. Postnuclear whorls rather high between summit and suture, with a broad, sloping, tabulated shoulder. The whorls are crossed by strong axial ribs which extend strongly from the summit to the periphery and feebly over the base, forming slender cusps at the shoulder near the summit. Of these ribs, 16 occur upon the first and second, 18 upon the third and fourth, 10 upon the fifth, 22 upon the sixth, and 24 upon the last turn. These ribs are about half as wide as the spaces that separate them. The latter are decidedly excavated between the shoulder and the suture, the termination of the excavation forming almost a keel at the periphery of the last whorl. Suture somewhat constricted. Base short, well rounded. Aperture oval; posterior angle obtuse; outer lip thin at the edge, showing the external sculpture within; inner lip curved, slightly reflected and appressed to the base for its anterior three-fifths.

The type, Cat. No. 359749, U.S.N.M., has 8 postnuclear whorls, having lost the nucleus, and measures: Length, 3.9 mm.; diameter, 1.2 mm. The nuclear whorls were described from a young specimen. Cat. No. 359750, U.S.N.M., contains another specimen from the type locality.

This species differs from *Turbonilla* (*Turbonilla*) *centrota* Dall and Bartsch in being stouter and having the tabulated shoulder at the summit much more sloping.

TURBONILLA (STRIOTURBONILLA) EVAGONE, new species.

Plate 1, fig. 4.

Shell elongate-conic, bluish white. Nuclear whorls decollated. Postnuclear whorls flattened on the sides, almost excurved at the summit, which is narrowly tabulatedly shouldered, crossed by numerous axial ribs, which have a decidedly protractive slant, and which feebly crenulate the summit. Of these ribs, 18 occur upon the first and second, 20 upon the third to fifth, 22 upon the sixth and seventh, 26 upon the eighth, 28 upon the ninth, and 30 upon the last turn. These ribs are about as wide as the spaces that separate them. The latter are deeply impressed and terminate a little anterior to the periphery, leaving a narrow, smooth band at the suture. Periphery of the last whorl well rounded. Base moderately long, well rounded, smooth, excepting lines of growth. The entire surface of the spire and base is marked by microscopic spiral striations. Aperture oval; posterior angle acute; outer lip moderately thick, showing the external sculpture within; inner lip somewhat sinuous, reflected and appressed for its posterior third to its preceding turn, and provided with an oblique obsolete fold a little anterior to the insertion of the columella; parietal wall covered by a thin callus.

The type, Cat. No. 359751, U.S.N.M., has 10.6 postnuclear whorls and measures. length, 6.2 mm.; diameter, 1.7 mm. Cat. No. 359752, U.S.N.M., contains 7 additional specimens from the type locality.

This is nearest related to *Turbonilla* (*Strioturbonilla*) *panamensis* C. B. Adams, but differs from it by its larger size, more robust form and more numerous ribs.

TURBONILLA (STRIOTURBONILLA) NYCHIA, new species.

Plate 2, fig. 6.

Shell broadly elongate-conic, bluish white. Nuclear whorls two and a third, forming a depressed helicoid spire, the axis of which is at right angles to the nuclear turns, in the first of which the nuclear spire is about one-third immersed. Early postnuclear whorls strongly rounded, the later ones less so, appressed at the summit, crossed by curved, protractively slanting axial ribs, of which 20 occur upon the first and second and 22 upon the remaining turns. These ribs become somewhat enfeebled toward the summit, which they render slightly sinuous. Intercostal spaces a little wider than the ribs, crossed by 23 incised spiral lines, of which the 11 occurring on the posterior two-fifths are a little finer and closer spaced than the rest, the twelfth being a little stronger. The 10 succeeding are again subequal, while the twenty-third forms a deep peripheral pit. The latter is separated from the rest by a little wider space. The space

separating the twenty-second from the twenty-third is much wider than the rest and appears like a smooth girdle. Periphery of the last whorl well rounded. Base short, well rounded, marked by twenty-five fine, incised spiral lines, those on the columella separating cords a little stronger than the rest.

The type, Cat. No. 359758, U.S.N.M., has 8.5 postnuclear whorls and measures; length, 4.5 mm.; diameter, 1.3 mm.

TURBONILLA (STRIOTURBONILLA) THYNE, new species.

Plate 1, fig. 2.

Shell very regularly conic, subdiaphanous, bluish white. Nuclear whorls two and a half, forming a moderately elevated spire, the axis of which is at right angles to that of the succeeding turns, in the first of which the nuclear spire is about one-third immersed. Postnuclear whorls slightly rounded, narrowly shouldered at the summit, marked by strong, retractively slanting, slightly curved axial ribs, of which 14 occur upon the first and second, 16 upon the third to sixth, and 18 upon the last turn. These ribs extend prominently from the summit, which they render slightly wavy, to the periphery. Intercostal spaces a little wider than the ribs, strongly impressed, terminating at the periphery. Suture moderately constricted. Periphery of the last whorl well rounded. Base short, well rounded, smooth. Aperture subquadrate; posterior angle acute; outer lip thin, showing the external sculpture within; inner lip almost vertical, slightly flexuous, reflected over the posterior half to the base, provided with an obsolete fold a little anterior to its insertion.

The type, Cat. No. 359759, U.S.N.M., has almost 8 whorls and measures: length, 3.4 mm.; diameter, 1.1 mm.

The extremely regular conic outline and large ribs will distinguish this from any of the other species.

TURBONILLA (PYRGISCUS) MELEA, new species.

Plate 2, fig. 8.

Shell very slender, elongate-conic, yellowish white, with a little deeper yellow band about one-fourth of the distance between the summit and the suture anterior to the summit. Nuclear whorls and early postnuclear whorls decollated. Postnuclear whorls very high between summit and suture, appressed at the summit, marked by broad, low, rounded, almost vertical axial ribs, of which 20 occur upon the first and second of the remaining turns, 21 upon the third and fourth, and 28 upon the last whorl. Intercostal spaces about half as wide as the ribs, marked by 18 slender spiral threads which leave the spaces between them as deeply impressed oblong pits.

Suture slightly constricted. Periphery of the last whorl well rounded. Base short, well rounded, marked on the anterior two-thirds by 6 subequally spaced incised spiral lines, of which the posterior four are a little stronger than the rest. Aperture oval; posterior angle acute; outer lip thin, showing the external sculpture within; inner lip flexuous, reflected over and appressed to the base for three-fourths of its length, and provided with a rather strong fold a little anterior to its insertion; parietal wall covered by a thin callus.

The type, Cat. No. 359760, U.S.N.M., has 5.8 whorls remaining, which measure: Length 4.1 mm., diameter 1 mm.

TURBONILLA (PYRGISCUS) EVADNA, new species.

Plate 2, fig. 7.

Shell elongate-conic, bluish white, semidiaphanous. Nuclear whorls decollated. Postnuclear whorls high between summit and suture, appressed at the summit, crossed by low, rounded, almost vertical axial ribs, of which 18 occur upon the first and second of the remaining turns, 20 upon the third, 22 upon the fourth, 24 upon the fifth, 26 upon the sixth, and 27 upon the last whorl. These ribs become enfeebled toward the summit, which they render slightly sinuous. Intercostal spaces a little wider than the ribs, crossed by 11 incised spiral lines, which are of somewhat irregular strength and spacing, the peripheral and the one posterior to the periphery being much wider than the rest. Suture moderately constricted. Periphery of the last whorl well rounded. Base short, strongly rounded, marked by 8 rather strongly incised spiral lines, between which finer striations occur. Aperture oval; posterior angle obtuse; outer lip thin, showing the external sculpture within; inner lip sinuous, reflected over and appressed to the base for the posterior two-thirds of its length, provided with a strong obtuse oblique fold a little anterior to its insertion; parietal wall covered by a thick callus.

The type, Cat. No. 359761, U.S.N.M., has 8.5 whorls remaining and measures: Length 5.4 mm., diameter 1.3 mm.

TURBONILLA (BARTSCHELLA) SEMELA, new species.

Plate 2, fig. 1.

Shell elongate-conic, bluish-white, semitranslucent. Nuclear whorls, at least two, forming a depressed helicoid spire, which is obliquely half immersed in the first of the succeeding turns. Postnuclear whorls strongly rounded, appressed at the summit, marked by very slightly protractive slender axial ribs, of which 22 occur upon the first, 24 upon the second and third, and 26 upon the remain-

ing turns. The intercostal spaces are a little wider than the ribs. In addition to the axial sculpture, the whorls are marked by 5 spiral cords of which the first is at the summit, and is a little broader than the rest. These spiral cords are equally spaced. The intersections between them and the axial ribs form low, rounded nodules, while the spaces enclosed between them form slightly elongated pits, the long axis of which coincides with the spiral sculpture. Suture moderately constricted. Periphery of the last whorl marked by a spiral cord similar to those on the spire. Base short, well rounded, marked by 5 spiral cords between the peripheral cord and the insertion of the columella, which grow consecutively smaller from the posterior anteriorly, the columella being marked by 3 slender spiral threads. Aperture broadly oval; posterior angle acute; outer lip thin, showing the external sculpture within; inner lip almost straight, reflected over and appressed to the base for almost its entire length, provided with a moderately strong fold a little anterior to its insertion.

The type, Cat. No. 359762, U.S.N.M., has 6.5 postnuclear whorls and measures: length, 3.5 mm.; diameter, 1.2 mm.

The present species is nearest related to *Turbonilla* (*Bartschella*) *andrewsi* Dall and Bartsch from Panama, from which it differs by its white color, much larger size and more elegant sculpture

ODOSTOMIA (CHRYSALLIDA) OLSSONI, new species.

Plate 2, fig. 3.

Shell elongate-ovate, bluish white. Nuclear whorls decollated in part, the remaining portion deeply immersed in the first of the succeeding turns. Postnuclear whorls strongly, tabulatedly shouldered at the summit, marked by very strong, slightly protractively slanting, almost vertical axial ribs, of which 18 occur upon the first, 20 upon the second, and 18 upon the remaining turns. Intercostal spaces about one and a half times as wide as the ribs. The spiral sculpture consists of 4 spiral cords which are not as strong as the axial ribs, the first of which is at the summit. These cords divide the space between the summit and the periphery into three equal spiral zones of pits. In the later whorls the summit of the turn drops below the periphery and leaves the peripheral cord in the suture. This is as strong as the spiral cords on the spire. Suture strongly channeled. Base rather long, marked by 5 strong spiral cords, the spaces between which are crossed by numerous fine axial threads. Aperture oval; posterior angle obtuse; outer lip fractured; inner lip stout, reflected over and appressed to the base, and provided with a very strong oblique fold a little anterior to its insertion.

The type, Cat. No. 359763, U. S. N. M., has 6⅓ postnuclear whorls and measures: Length, 3.1 mm.; diameter, 1.2 mm.

The present species is related to *Odostomia* (*Chrysallida*) *excelsa* Dall and Bartsch from Panama, but differs from it in having 5 instead of 8 much stronger spiral cords on the base.

ODOSTOMIA (CHRYSALLIDA) MELITTA, new species.

Plate 2, fig. 2.

Shell elongate-conic, bluish white, semitranslucent. Nuclear whorls decollated. Postnuclear whorls narrowly, tabulatedly shouldered at the summit, flattened in the middle, marked by very strong, slightly protractively slanting axial ribs, of which 16 occur upon the first of the remaining turns, 18 upon the second, third, and fourth, and 20 upon the last. These ribs are almost as wide as the spaces that separate them. The spiral sculpture consists of 4 strong spiral cords which do not quite equal the ribs in strength. The first of these is at the summit, while the other three divide the spaces between the summit and the suture into three equal areas. The junction of the axial ribs and spiral cords forms low rounded tubercles, while the spaces between them enclose rounded pits. Beginning with the antipenultimate turn, the peripheral cord shows at the suture, and on the last turn it is completely free therein. This cord is a little less strong than those on the spire. Base rather long, marked by 7 strong spiral cords, those near the columella being a little less developed than the rest. The latter equal the peripheral cord in strength. The spaces between the cords equal the cords and are crossed by fine axial riblets. Aperture oval; posterior angle obtuse; outer lip thin, showing the external sculpture within; inner lip very stout, reflected over and appressed to the base, and provided with a very strong, almost lamellar oblique fold a little anterior to its insertion; parietal wall covered by a thick callus.

The type, Cat. No. 359764, United States National Museum, has 6 whorls remaining and measures: Length, 4.2 mm.; diameter, 1.4 mm.

This also belongs to the group of *Odostomia* (*Chrysallida*) *excelsa* Dall and Bartsch, but differs from it by its elongate-conic form (*excelsa* is elongate-ovate) and by its much larger size.

MELANELLA (MELANELLA) OLSSONI, new species.

Plate 2, fig. 4.

Shell regularly elongate-conic, bluish white, semitranslucent. Nuclear whorls decollated. Postnuclear whorls almost flattened, giving to the spire an almost straight outline, appressed at the summit. The basal portion of the preceding whorl shines through the substance of the succeeding turn at its summit, and gives this the appearance of having a double suture. Periphery strongly rounded.

Base rather long, well rounded. The entire surface of the shell is smooth, with a silky luster. Aperture oval. Posterior angle acute; outer lip slightly contracted near the summit, rather protracted in the middle, but scarcely produced into a clawlike element, thin: inner lip stout, reflected over and appressed to the base; parietal wall covered by a moderately thick callus.

The type, Cat. No. 359765, U.S.N.M., has 8.5 whorls and measures: length, 4.5 mm.; diameter, 1.4 mm.

MELANELLA (BALCIS) ELENENSIS, new species.

Plate 2, fig. 5.

Shell elongate-conic, slightly falciform, bluish white. Nuclear whorls decollated. Postnuclear whorls appressed at the summit, very slightly rounded, forming an almost straight-sided spire. Suture but slightly constricted. Periphery of the last whorl well rounded. Base produced, well rounded. Entire surface smooth with a silky luster. Aperture suboval; posterior angle acute; outer lip thin, slightly contracted immediately below the posterior angle, but scarcely produced into a claw-like element anterior to this; inner lip stout, very oblique, reflected over and appressed to the base; parietal wall covered by a thin callus.

The type, Cat. No. 359766, U.S.N.M., has 8.5 whorls and measures: length, 4.5 mm.; diameter, 1.2 mm. Cat. No. 359767, U.S.N.M., contains a young specimen of 5.8 whorls from the same locality.

EXPLANATION OF PLATES.

PLATE 1.

FIG. 1. *Turbonilla (Turbonilla) axeli.*
2. *Turbonilla (Strioturbonilla) thyne.* Spiral sculpture too fine to be shown in figure.
3. *Turbonilla (Chemnitzia) oenoa.*
4. *Turbonilla (Strioturbonilla) evagone.* Spiral sculpture too fine to be shown in figure.
5. *Pyramidella (Longchaeus) elenensis.*
6. *Turbonilla (Chemnitzia) theone.*

PLATE 2.

FIG. 1. *Turbonilla (Bartschella) semele.*
2. *Odostomia (Chrysallida) melitta.*
3. *Odostomia (Chrysallida) olssoni.*
4. *Melanella (Melanella) olssoni.*
5. *Melanella (Balcis) elenensis.*
6. *Turbonilla (Strioturbonilla) nychia.*
7. *Turbonilla (Pyrgiscus) evadne.*
8. *Turbonilla (Pyrgiscus) melea.*

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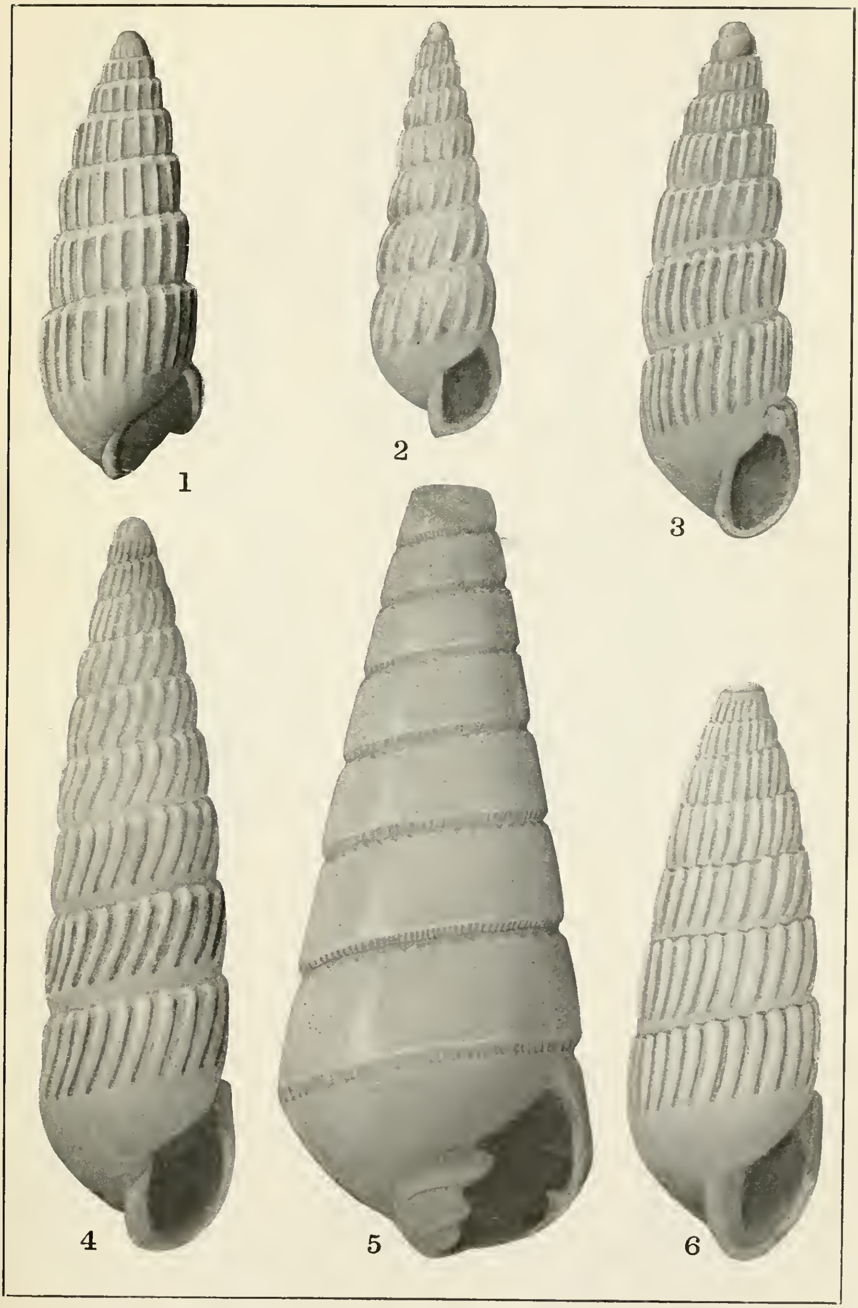
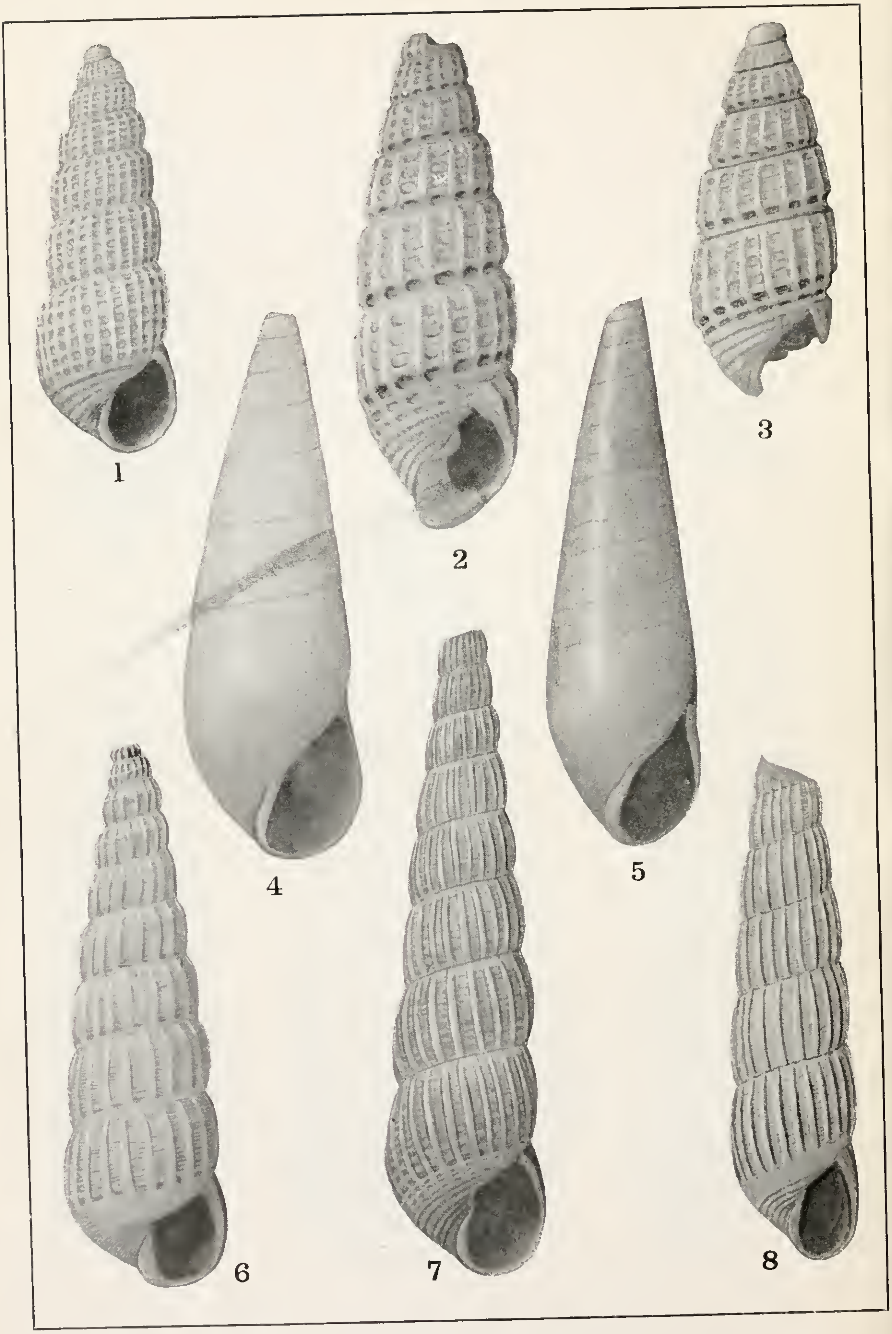


NEW MOLLUSKS FROM ECUADOR

FOR EXPLANATION OF PLATE SEE PAGE 9



NEW MOLLUSKS FROM ECUADOR

FOR EXPLANATION OF PLATE SEE PAGE 9

NEW URUGUAYAN MOLLUSKS OF THE GENUS CORBICULA.

By William B. Marshall,

Assistant Curator, Division of Mollusks, United States National Museum.

A large collection of Uruguayan *Corbicula* recently received from Dr. Florentino Felippone, of Montevideo, part as a gift to the United States National Museum and part for identification, necessitated a careful study of the South American shells of this genus. At once it became apparent that much of the material received does not fall into any of the known species and in order properly to classify them, it became necessary to describe the eight new species herein named. A specimen and an odd valve from Mr. S. Olea, of Montevideo, have lain in the collection unidentified for about 18 years An odd valve of the same kind just received from Doctor Felippone further confirms the belief that these shells belong to a new species which is herein described under the name *oleana.* The preeminent *Corbicula* of the Uruguayan and southern Brazilian region is *limosa* Maton, the first species described. It seems to be the most abundant *Corbicula* in the region, but there may be several species or subspecies included under this name. Surely the shells placed here exhibit a wide range of variation in form, size, and color. Some of the southern Brazilian forms are long, but little resembling the typical triangular forms. Abundant material and a study of the distribution in the various river systems is needed to clarify this species.

The narrow radiating lines of color (usually reddish or chestnut) so often seen in some of the species deserve some notice. In specimens of the same species they may or may not be present. They seem to be in the periostracum but in fact they are in the calcareous portion of the shell and are seen through the periostracum. The collection of the National Museum contains a number of specimens in which part of the periostracum has been rubbed away and in which the color rays are very prominent on the calcareous part thus exposed to view. No color rays are to be seen in the periostracum

where it remains but has curled away from the ray in the shelly substance.

The two chief facts which have been discovered in the Corbiculidae since the time at which these mollusks were segregated into a family by themselves lie in a discovery made by Prime and a later one made by Dall. Prime's discovery is given in the following sentence quoted from his Monograph of American Corbiculadae (Recent and fossil).[1] "A peculiarity of the *Corbicula* found in America, which they share with our *Cyrena*, lies in the fact that the pallial impression always terminates in a sinus, whereas in the species from other regions it is simple."

Dall discovered the fact that *Corbicula limosa* and *C. obsoleta* are viviparous. See his Note on *Neocorbicula* Fischer.[2]

Two specimens from Doctor Felippone from Colonia, Uruguay, contain nepionic young, thus proving anew that at least some of the species are viviparous as pointed out by Dall.

Both shells are quite small, showing that breeding begins at an early stage. One, at least, is positively *Corbicula limosa*. This specimen measures 11 mm. in length and 9 mm. in height. It contains embryos from the egg up to shells of a considerable size, giving one the idea that the production of young must be somewhat continuous, at least during the breeding season, and that it does not take place in a short space of time. The largest of the young, probably ready for extrusion, measures 2 mm. in length and 1.75 mm. in height. This is a considerable size when compared with the size of the parent.

The tip of the young shell is transparent, glasslike, and very small. It is prominent like the tip of the genus *Musculium*. A fairly well-marked concentric groove indicates the first period of development. This is followed by several concentric impressed striae and the later portion of the shell has concentric striae resembling on a small scale those of the adult. These little shells are flesh colored, with bright rays of pale chestnut, not evenly distributed, but arranged singly or in pairs or trios. In coloring, the baby shell thus resembles the mother.

The other specimen mentioned as containing young is of about the same size as the one we have been considering, but it has no rays of color, and it is a little off form for *Corbicula limosa*. The nepionic young in this specimen resemble the mother in having no rays of color.

The nepionic young of a specimen of *Corbicula obsoleta* in the collection of the United States National Museum mimic the mother in

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[1] Smiths. Mis. Coll. No. 145, p. 3, Dec. 1865.

[2] The Nautilus, vol. 16, pp. 82, 83, Nov., 1902.

form. The young have an oblique splash of purple in front and back of the beaks, both splashes pointing in a general way toward the posterior ventral angle. The beaks of the mother shell are much eroded so that purple as splashes can not be seen, but the beak in general is purple.

Data regarding the nepionic young of the various species are woefully lacking, but from what has been observed one gathers the idea that a very careful study of the embryology of the *Corbiculas* would lead to a more accurate understanding of what species there are. This, with geographic distribution, should clarify our knowledge of the South American species of this genus.

CORBICULA (CYANOCYCLAS) CIRCULARIS, new species.

Plate 2, figs. 1–3.

Shell subcircular in outline, very compressed, rather solid, posterior margin very slightly, obliquely truncated. Hinge line much arched, anterior and ventral margins regularly, nearly circularly, curved; beaks not much elevated, posterior and anterior ridges nearly equal in height, the whole surface being nearly of a uniform convexity; color in type bleached straw, becoming greenish around the margin (in the cotype the whole surface is a dirty greenish with an undertone of straw color); sculpture consisting of a number of engraved concentric lines with concentric striae between them and several more plainly marked growth lines. Both cotypes are left valves. The hinge area broad, the middle cardinal tooth bifid, the anterior one smaller but strong, the posterior one very small and weak, long and knifelike. Anterior lateral standing out prominently on the hinge plate, thin, long, slightly bowed, undulated on its edge, coarsely striated and with radiating oblique grooves on its outer surface. Posterior lateral holding the same direction as the third cardinal, slightly bowed, its front end elevated, its edge crenulated, and its outer face rudely striated. The ligamental scar (sinulus) relatively large. Pallial line in type about 5 mm. from ventral margin, well marked, the sinus rather small. Color of interior of both cotypes plain white.

The type, Cat. No. 347860, U.S.N.M., measures: Length, 25 mm.; height, 24 mm.; diameter if both valves were present would be 12 mm. The cotype measures: Length, 20 mm.; height, 18.5 mm. They come from the Uruguay River, Uruguay, and were presented by Doctor Felippone.

The nearly circular outline, the compressed form, and the nearly regular convexity distinguish this species from all others yet known.

CORBICULA (CYANOCYCLAS) COMPACTA, new species.

Plate 2, figs. 10–12.

Shell moderately inflated, thick, compact, subrotund in outline, narrower in front. Ventral margin slightly curved, anterior margin narrowly curved, posterior margin sweepingly curved. Beaks rather high and full, so placed as to give the shell an appearance of being tilted forward. Posterior ridge prominent, obscurely subangular; anterior ridge hardly apparent. Sculpture of rather distant but moderately strong concentric growth striae, which are much stronger on the anterior area. Periostracum clothlike, dull. Color light chestnut brown, with several indistinct, hairlike darker rays. These rays are on the calcareous portion of the shell, but at places may be seen through the translucent periostracum. Beaks eroded, allowing it to be seen that the texture of the shell is of a pink color. Interior rose pink, paler toward the margins. Cardinal teeth widely diverging. In the right valve the first cardinal is reduced to a mere point, the middle cardinal rather strong and bifid, the third about as strong as the second and obscurely bifid. Anterior laterals of the valve rather long, slightly bowed, the inner one the stronger and striated on its upper face, the outer one weak. Posterior laterals of this valve very short, the inner one stronger and weakly striated on its upper face, the outer one very weak. In the left valve the first cardinal tooth is thin and platelike, the second is stronger and obscurely bifid, the third is an elevated, thin plate. The anterior lateral tooth of this valve is bowed and irregularly crenulated and striated. The posterior lateral is extremely short and weakly striated. Adductor scars and pallial line impressed, the pallial sinus very marked.

The type, Cat. No. 349175, U.S.N.M., measures: Length, 25 mm.; height, 22.5 mm.; diameter, 17.5 mm. It comes from Doctor Felippone, who collected it at Paysandu, Uruguay.

The chunky form, compactness, pinkish color, and especially the very small posterior lateral teeth afford easy means of identifying this species.

CORBICULA (CYANOCYCLAS) DELICATA, new species.

Plate 2, figs. 4–6.

Shell moderately compressed, subquadrate in outline, wide posteriorly, where it is roundly truncate. Anterior end shortly rounded, ventral margin slightly rounded, hinge line very lightly arched, beaks a little behind the middle. Posterior ridge moderately high, rounded, posterior dorsal area sloping gently from the ridge to the margin, wide. Sculpture of very fine concentric striae, the rest periods indicated by a deeper line and of dark color. Periostracum clothlike, not

shining. General color light olive green, the margin salmon color, posterior area with three broad rays of salmon color and three rays of greenish. Faint indication of narrow dark rays elsewhere. Interior of the shell purplish gray with whitish margin, the posterior end with three broad rays of purple and three of salmon. Cardinal teeth widely divergent, more plainly bifid than in most *Corbicula*. Anterior laterals of right valve rather long, plainly curved at the lower end, posterior laterals short, high at its upper end. Pallial line and sinus fairly well marked.

The type, Cat. No. 347862, U.S.N.M., measures: Length, 11 mm.; height, 9 mm.; diameter, 4 mm. It was presented by Doctor Felippone, who collected it in the Department of Paysandu, Uruguay. It is a young specimen, but was selected for type as it is the only one of the lot received which is nearly perfect. The species becomes much larger—another specimen measuring: Length, 20 mm.; height, 17 mm.; diameter, 9 mm. Its nearest relative is *limosa* Maton, from which it differs slightly in form and greatly in coloring.

CORBICULA (CYANOCYCLAS) EXQUISITA, new species.

Plate 1, figs. 9, 10, 12.

Shell thin, very inflated, cordate, beaks turning forward, dorsal line lightly arched, posterior margin nearly squarely truncate, distinctly angled above, obscurely angled below. Anterior margin rounded, the anterior portion of the shell advancing, giving the shell a pouting appearance. Ventral margin rounded, posterior ridge high, rounded, posterior area very broad, obscurely, cordately sulcate beaks a little back of the middle of the dorsal line, eroded but retaining traces of rather heavy concentric, raised lines. Color very light chestnut, uniform, but sparingly rayed with very narrow darker chestnut lines. Posterior area with three broad radiating livid stripes. Beaks with a pinkish tinge. Sculpture consisting of numerous concentric raised lines, which are stronger anteriorly and crowded and much finer posteriorly. Periostracum thin, somewhat shining. Ligament very short, close to the beaks. Interior of shell pinkish everywhere. Anterior cardinal tooth of right valve very small, triangular, very sharp, the other two fairly strong, and both of them markedly bifid. Laterals in this valve double, the inner ones crenulate on edge and coarsely striate on upper surface. In left valve the first and second cardinals are fairly strong and slightly bifid, the third cardinal thin, high, platelike, pointed. Anterior lateral crenulated, strongly striate on its outer face and with oblique shallow grooves cutting across the striae. Posterior lateral remote from beaks very high, nearly pointed at its middle, obscurely crenulated and striated.

Pallial line well marked, about 4 mm. from ventral margin, pallial sinus distinct, acutely pointed.

The type, Cat. No. 347866, U.S.N.M., measures: Length, 19 mm.; height, 17 mm.; diameter, 13 mm. It and an odd valve, Cat. No. 347867, U.S.N.M. come from the Department of Colonia, Uruguay, and were collected and presented by Doctor Felippone. His collection (No. 1580) contains one right valve from the same place.

This species is entirely different from any hitherto known and will be easy to recognize. Structure, color, form, and other feature of the shell are so superior to the usual *Corbicula* that they have suggested the specific name. A general pinkish or salmon tinge pervades the whole shell. The valve in Doctor Felippine's collection is decorticated, thus showing the shell color unobscured by the periostracum. It is plainly to be seen that not only the surfaces of the calcareous portion of the shell but the texture of this portion itself is of this color.

CORBICULA (CYANOCYCLAS) FELIPPONEI, new species.

Plate 1, figs. 1, 7, 11.

Shell large, thick, heavy, subcircular in outline, posterior margin slightly truncated. Beaks eroded, high, located just in front of the middle. Anterior margin sloping slightly from the beaks, then curving regularly into the regularly curved ventral margin which joins the posterior margin in a rounded angle. Posterior dorsal area appearing to be pinched. Posterior dorsal ridge rounded but prominent. Sculpture consisting of a number of rude lines of growth, with minor lines between them. Growth lines crowded anteriorly and posteriorly and near the ventral margin. Color of exterior blackish brown, with chestnut tints here and there. Color of interior very striking, of various shades of white, flesh-color, pink, lavender, and purple. Cavity of the beaks white, teeth and a broad irregular band round the whole margin pink, flesh color, or lavender; a broad zone of which the pallial line marks the middle is of various tints of purple. Between the pallial line and the ventral margin are nine or ten purple rays pointing toward the beaks. A broad purple ray extends from near the beak to the upper part of the posterior adductor scar. Cardinal teeth of the usual type but large and thick; between the cardinals and the beginning of the posterior lateral teeth the hinge plate is very broad, somewhat as in *Batissa*. Lateral teeth very strong, double in the right valve, single in the left, all of them rather short. Anterior laterals of right valve nearly straight, the groove between them narrow, the inner one the stronger, its upper edge undulating and crenulated. Posterior laterals of right valve with a wide groove between them, the inner lateral nearly

straight, its edge crenulated and its upper face with several oblique grooves, the outer tooth much arched. Anterior lateral of left rudely crenulate and undulating, posterior lateral of this valve very high, especially at its upper end, its edge finely crenulate and undulating, its upper face with granulous striae and with several oblique shallow grooves. Pallial line about 7 mm. from ventral margin, well marked, the sinus large and acutely pointed, the space between the pallial line and ventral margin radially roughened. Anterior adductor scar deep and with many strongly marked growth lines; posterior scar well marked but not deep, its growth lines hardly visible.

The type, Cat. No. 347868, U.S.N.M., measures: length, 39 mm.; height, 35 mm.; diameter, 20 mm. It comes from the Department of Colonia, Uruguay, and was collected and presented by Dr. Florentino Felippone. A specimen in Doctor Felippone's collection, (his No. 1624) is labelled Rio Uruguay, Uruguay. It measures: length, 32 mm.; height, 25 mm.; diameter, 16 mm.

Two odd valves, Cat. No. 347871, U.S.N.M., from the Uruguay River, Nueva Palmira, Department of Colonia, Uruguay, are more inflated, have a cordate form and have a number of ribs for concentric sculpture. More material may show these to belong to a subspecies.

This is the largest American *Corbicula* known, the nearest approach to it in size being *C. coloniensis* Pilsbry, for one specimen of which Pilsbry gives the measurements as: Length, 32½ mm.; altitude, 27½ mm.; diameter, 15½ mm. In size and coloring *felipponei* reminds one of some of the species from the Far East, but of course this species being South American shows a very well-marked sinus near the posterior end of the pallial line.

CORBICULA (CYANOCYCLAS) FORTIS, new species.

Plate 2, figs. 7–9.

Shell subtriangular, inflated, very thick, especially at the upper portion. Posterior margin long and straight, making a sharp angle with the ventral margin. Anterior margin nearly straight, not quite so long, shortly rounding into the ventral margin, the latter nearly regularly curved. Posterior and anterior ridges both high, the former subangulate, the latter rounded. Posterior area very wide, nearly at right angles to the convexity of the shell. When the valves are closed their united posterior areas are distinctly wedge-shaped. Beaks high and narrow, well separated. Hinge line greatly arched, especially between the third cardinal tooth and the posterior laterals. Sculpture consisting of numerous fine concentric lines of slightly raised lamellae. Color uniform brownish-olive (Saccardo's olive). Color of interior deep purple, white around the margin. In right

valve the first cardinal tooth is a mere point, the second is strong, and thick and weakly bifid, the third is moderately stout, long, and prominently bifid—anterior laterals of this valve short, the inner one very thick and wavingly striated on its upper face, outer one weak, sharp, its lower end abruptly curved to join the inner lateral, groove very wide and deep. In the left valve the first cardinal is triangular, high and sharply pointed, the second is strong and so deeply bifid as to appear like two teeth fused at the base, the third cardinal is long and platelike. Anterior lateral of this valve thick with edge very undulating and it and the upper face coarsely striated. Posterior lateral of this valve thick with both its outer and inner faces coarsely striated. Adductor scars, pallial line and sinus all deeply impressed.

The type, Cat. No. 347874, U.S.N.M., measures: Length, 21 mm.; height, 20 mm.; diameter, 14 mm. It comes from the Department of Colonia and was collected and presented by Doctor Felippone.

Cat. No. 109265, U.S.N.M., contains two small specimens and four odd valves from Arroyo de Pando, Department of Canelones, which were received many years ago from Mr. S. Olea, of Montevideo. Cat. No. 347876, U.S.N.M., contains a number of odd valves from the Department of Paysandu received from Doctor Felippone. Unlike the type, many of them show several radiating lines of color. These lines show on the calcareous portion of several specimens which are almost entirely decorticated, and apparently it is in this part of the shell that the color lines are located, showing through the periostracum when it is present.

The nearest relative of this species is *C. felipponei*, which, however, is much larger, more rounded, not so thick, and of different color.

CORBICULA (CYANOCYCLAS) OLEANA, new species.

Plate 1, figs. 2–4.

Shell cordate, very oblique, very thick, much inflated, slopingly rounded on posterior margin, angularly rounded on anterior margin. Ventral margin regularly rounded. Beaks very high, projecting far above the hinge line, which is much arched. Posterior ridge high, rounded. Upper portion of shell with several very high, thin, concentric ridges, and whole surface with obscure concentric growth striae. Posterior dorsal area with several obscure curved radiating striae. Periostracum smooth, dull, unctuous, of a yellowish-olive color, marked with a number of narrow radiating lavender-colored lines. Area occupied by cardinal and lateral teeth, wide, thick, solid, and strong. Cardinal teeth subparallel, fairly strong, all of them bifid at the top. Laterals of right valve double, short, slightly bowed, the inner ones moderately strong, the outer ones low and weak, the grooves between the outer and inner ones very wide. Laterals of left

valve very thick, especially at the base. Color of interior various shades of purple and ash-gray, the latter color forming a narrow band around the margin, and inside of this are two irregular zones of purple with ash-gray between them. Adductor scars purple and a spot of the same color at the upper end of the lateral teeth of each valve. Cavity of the shell lavender. Adductor scars and sinus of the pallial line deeply impressed.

The type, Cat. No. 109261, U.S.N.M., measures: length, 7.5 mm.; height, 9 mm.; diameter, 9 mm. It and an additional left valve come from Arroyo de Malvin, Department of Montevideo, Uruguay, and were presented by Mr. S. Olea, in whose honor the species is named. It was in specimens of *Corbicula* presented by Mr. Olea that Doctor Dall made the first discovery of viviparity in this genus.

Cat. No. 334554, U.S.N.M., contains a left valve of this species from the Uruguay River, Paysandu, Uruguay, from Doctor Felippone.

The obliquity, the strength, the very cordate form, and especially the concentric ridges on the upper half of each valve make this species easy of identification.

CORBICULA (CYANOCYCLAS) PAYSANDUENSIS, new species.

Plate 1, Figs. 5, 6, 8.

Shell inflated, subquadrate in outline, shortly rounded anteriorly, nearly squarely truncated posteriorly, beaks a little back of the middle, posterior ridge high, subangular, anterior end of shell pouting forward. Periostracum not glossy, smooth, unctuous. Sculpture consisting of a number of elevated concentric ridges near the beaks and similar concentric ridges on most of the anterior area which die out before reaching the main convexity of the shell. There are numerous weak growth striae, but the principal rest periods are well marked by a stronger line and a band of darker color. Posterior area with indications of several weak radiating raised lines. Color dark olive green, with indications of several narrow radiating, chestnut-colored lines. Color of interior purplish gray, the radiating chestnut lines of the exterior showing between the pallial line and the margin. Cardinal teeth moderately diverging. In the right valve the first cardinal is small and pointed, the second is strong and bifid, the third not quite so strong but more deeply bifid. In the left valve the first cardinal is high and pointed, the second bifid on its ventral face, the third long and with a raised point at its lower end. Anterior laterals of right valve nearly straight, subequal in strength, the inner one sharply crenulate. Posterior laterals in this valve remote from beaks, short, much bowed, the inner one crenulate. In the left valve the anterior lateral is thin, crenulated; posterior one

remote from beaks, very short, its middle point high and moderately sharp. Pallial line well marked, the sinus quite large for a shell of this size.

The type, Cat. No. 270895, U.S.N.M., measures: length, 13 mm.; height, 11.5 mm.; diameter, 7 mm. It comes from the Uruguay River, Paysandu, Uruguay, and was collected and presented by Dr. Florentino Felippone. In form this species approaches *C. exquisita*, but differs in color and especially in possessing the strong concentric ridges near the beaks and on the anterior area.

SPECIES OF CORBICULA (CYANOCYCLAS) CHRONOLOGICALLY ARRANGED AND WITH ORIGINAL GENERIC DESIGNATIONS.

1809. *Tellina limosa* MATON.
Trans. Linn. Soc. London, vol. 10, p. 325, pl. 24, figs. 8–10.
Type locality: Rivers of South America.

1835. *Cyrena variegata* ORBIGNY.
Mag. de Zool., vol. 5, p. 44.
Type locality: Rivers of Uruguay, La Plata River at Buenos Aires, Parana River as far as Corrientes.
A synonym of *limosa* Maton.

1835. *Cyrena paranacensis* ORBIGNY.
Mag. de Zool., vol. 5, p. 44.
Type locality: Parana River from its mouth to above Corrientes.

1844. *Cyrena cuneata* JONAS.
Zeit. für Malak., p. 186.
Type locality: Orinoco River.

1844. *Cyrena globulus* JONAS (in litt.).
Zeit. für Malak., p. 186. (Not described. Here Jonas states that it is the same as *C. cuneata* Jonas.)

1846. *Cyclas paranensis* ORBIGNY.
Voy. Amer. Merid., p. 56, pl. 83, figs. 25–27.
A correction for *Cyrena paranacensis* Orbigny.

1854. *Corbicula brasiliana* DESHAYES.
Bivalves Brit. Mus., p. 232.
Type locality: Para, Brazil.
Deshayes refers to Proc. Zool. Soc. London, p. 232, 1854, as place of original description. No such description occurs there.

1854. *Corbicula convexa* DESHAYES.
Proc. Zool. Soc. London, vol. 22, p. 342.
Type locality: Central America.

1854. *Corbicula incrassata* DESHAYES.
Proc. Zool. Soc. London, vol. 22, p. 342.
Type locality: Unknown.
Prime places it in the synonymy of *Corbicula cuneata* Jonas.

1854. *Corbicula obsoleta* DESHAYES.
Proc. Zool. Soc. London, vol. 22, p. 343.
Type locality: Uruguay.

1854. *Corbicula semisulcata* DESHAYES.
Proc. Zool. Soc. London, vol. 22, p. 343.
Type locality: Victoria River, Australia.
Locality evidently an error. Prime and Clessin place this in the synonymy of *Corbicula limosa* Maton.

1860. *Corbicula rotunda* PRIME.
Proc. Acad. Nat. Sci. Phila., p. 80.
Type locality: Surinam River, Guiana.

1865. *Corbicula perplexa* PRIME.
Smiths. Miscell. Coll. No. 145, p. 75.
Type locality: South America.

1870. *Corbicula amazonica* (Anthony) PRIME.
Prime in Ann. Lyc. Nat. Hist., New York, vol. 9, p. 299.
Type locality: Amazon River (in stomach of a fish).

1879. *Corbicula surinamica* CLESSIN.
Conch, Cab., vol 9, pt. 3, p. 178, pl. 31, figs. 7–9.
Type locality: South America (in stomach of a fish, *Doras costatus*).

1896. *Corbicula coloniensis* PILSBRY.
Proc. Acad. Nat. Sci., Phila., p. 562, pl. 26, fig. 9.
Type locality: Rio de la Plata, above Colonia, Uruguay.

1914. *Corbicula approximans* PRESTON.
Ann. and Mag. Nat. Hist., ser. 8, vol. 13, p. 528.
Type locality: Rio Bermejo, a tributary of Rio Chaco, N. Argentina.

1914. *Corbicula bermejoensis* PRESTON.
Ann. and Mag. Nat. Hist., ser. 8, vol. 13, p. 528.
Type locality: Rio Bermejo, a tributary of Rio Chaco, N. Argentina.

SPECIES HERE DESCRIBED.

Corbicula (*Cyanocyclas*) *circularis*. Type locality: Uruguay River, Uruguay.

Corbicula (*Cyanocyclas*) *compacta*. Type locality: Barra del Arroyo Sacra, Department of Paysandu, Uruguay.

Corbicula (*Cyanocyclas*) *delicata*. Type locality: Department of Paysandu, Uruguay.

Corbicula (*Cyanocyclas*) *exquista*. Type locality: Department of Colonia, Uruguay.

Corbicula (*Cyanocyclas*) *felipponei*. Type locality: Department of Colonia, Uruguay.

Corbicula (*Cyanocyclas*) *fortis*. Type locality: Department of Colonia, Uruguay.

Corbicula (*Cyanocyclas*) *oleana*. Type locality: Arroyo de Malvin, Department of Montevideo, Uruguay.

Corbicula (*Cyanocyclas*) *paysanduensis*. Type locality: Uruguay River, Paysandu, Uruguay.

EXPLANATION OF PLATES.

All figures $\times 1\frac{1}{2}$.

PLATE 1.

FIG. 1. *Corbicula* (*Cyanocyclas*) *felipponei*, new species. Interior of left valve.
2. *Corbicula* (*Cyanocyclas*) *oleana*, new species. Exterior of left valve.
3. *Corbicula* (*Cyanocyclas*) *oleana*, new species. Interior of left valve.
4. *Corbicula* (*Cyanocyclas*) *oleana*, new species. Dorsal view.
5. *Corbicula* (*Cyanocyclas*) *paysanduensis*, new species. Interior of left valve.
6. *Corbicula* (*Cyanocyclas*) *paysanduensis*, new species. Exterior of left valve.
7. *Corbicula* (*Cyanocyclas*) *felipponei*, new species. Dorsal view.
8. *Corbicula* (*Cyanocyclas*) *paysanduensis*, new species. Dorsal view.

9. *Corbicula* (*Cyanocyclas*) *exquisita*, new species. Dorsal view.
10. *Corbicula* (*Cyanocyclas*) *exquisita*, new species. Exterior of left valve.
11. *Corbicula* (*Cyanocyclas*) *felipponei*, new species. Exterior of left valve.
12. *Corbicula* (*Cyanocyclas*) *exquisita*, new species. Interior of left valve.

PLATE 2.

FIG. 1. *Corbicula* (*Cyanocyclas*) *circularis*, new species. Exterior of left valve.
2. *Corbicula* (*Cyanocyclas*) *circularis*, new species. Interior of left valve.
3. *Corbicula* (*Cyanocyclas*) *circularis*, new species. Dorsal view of left valve.
4. *Corbicula* (*Cyanocyclas*) *delicata*, new species. Exterior of left valve.
5. *Corbicula* (*Cyanocyclas*) *delicata*, new species. Dorsal view.
6. *Corbicula* (*Cyanocyclas*) *delicata*, new species. Interior of left valve.
7. *Corbicula* (*Cyanocyclas*) *fortis*, new species. Exterior of left valve.
8. *Corbicula* (*Cyanocyclas*) *fortis*, new species. Dorsal view.
9. *Corbicula* (*Cyanocyclas*) *fortis*, new species. Interior of left valve.
10. *Corbicula* (*Cyanocyclas*) *compacta*, new species. Exterior of left valve.
11. *Corbicula* (*Cyanocyclas*) *compacta*, new species. Dorsal view.
12. *Corbicula* (*Cyanocyclas*) *compacta*, new species. Interior of left valve.

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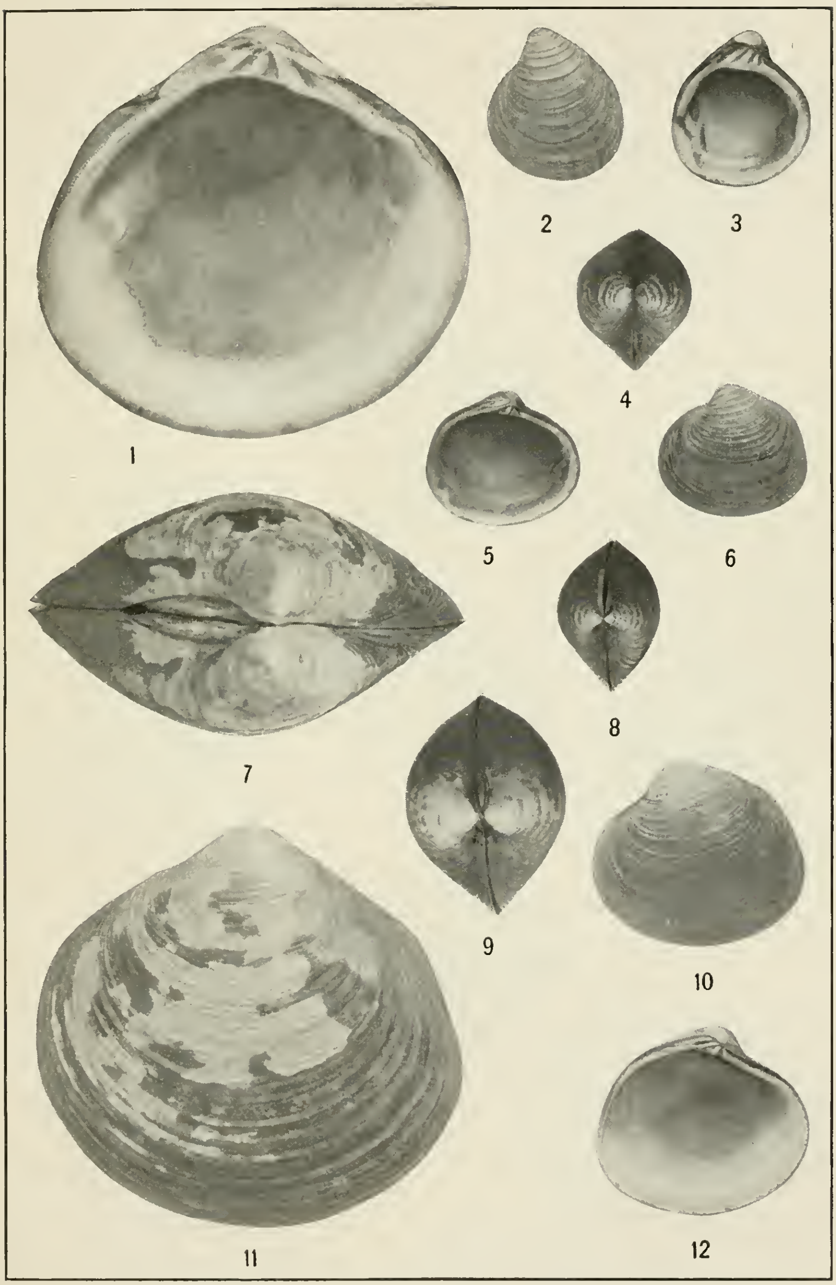
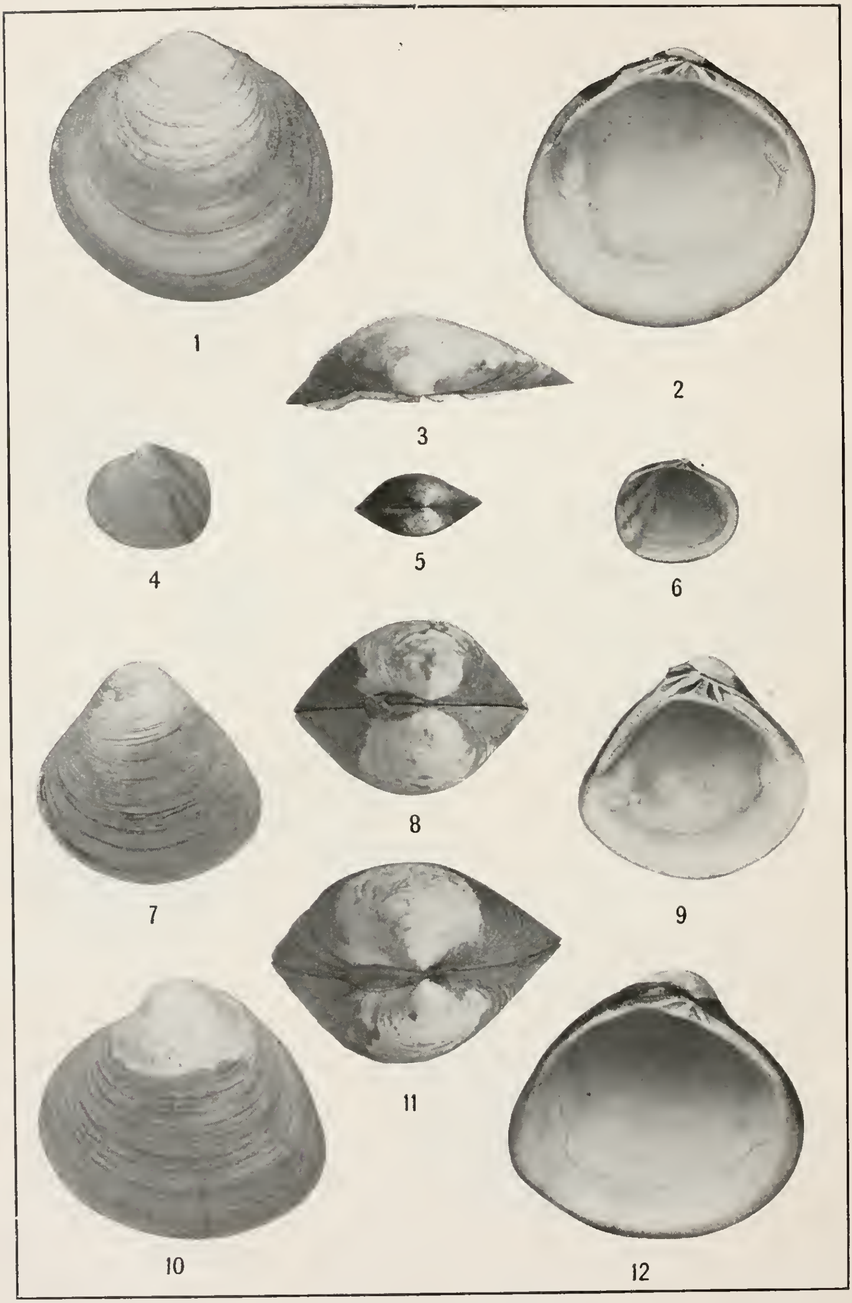


NEW URUGUAYAN CORBICULIDAE

FOR EXPLANATION OF PLATE SEE PAGES 11 AND 12



New Uruguayan Corbiculidae

For explanation of plate see page 12

SOME PARASITIC ROUND WORMS OF THE RABBIT WITH DESCRIPTIONS OF TWO NEW SPECIES.

By Asa C. Chandler,

Of the Biological Laboratory, Rice Institute, Houston, Texas.

In the course of parasitological examinations of domestic rabbits kept in the animal house of the Rice Institute biological laboratory, it was found that nearly every specimen was infested by trichostrongylid worms, and in some instances three different species were present in considerable numbers at the same time. The fact that immature specimens of all three species were present in some of the rabbits which had been kept in the animal house for from six weeks to two months, would seem to indicate that the infection, in some instances at least, was acquired in the animal house. Since all of the rabbits which have been kept in the house have been obtained in Texas, from breeders either in Houston or New Braunfels, it is probable that the worms originally came from Texas.

One of the species, and the one found in greatest abundance and in the largest number of individuals, is *Trichostrongylus calcaratus*. described by Ransom (1911) from cotton-tail rabbits, *Sylvilagus floridanus mallurus*, in Maryland. A number of young individuals of this species were found. The males, up to a length of about 3 to 3.5 mm., have the posterior end of the body terminated in a bulb with a conspicuous spine on the postero-dorsal extremity of it (fig. 1). Within the bulb the bursa of the adult develops, the body then drawing away somewhat from the larval cuticle, as shown in the figure. No doubt the final moult takes place shortly after this.

NEMATODIRUS LEPORIS, new species.

Plate 1, figs. 2–5.

Specific diagnosis. Long slender worms of small size, blood red when freshly removed. Inflated cuticle of neck asymmetrical, and conspicuously striated.

Male 8 to 13 mm. long with a maximum diameter of from 95 to 135 µ. Esophagus 400 to 500 µ in length. Bursa (fig. 3) well expanded, its breadth (250 µ), greater than its length (210 µ), an

unusual condition in the genus. Dorsal lobes of bursa set off from lateral lobes by a distinct notch and separated from each other by a shallow indentation. Dorsal ray moderately stout, bifurcated to about one-fourth its length from the tip of the longest prong. Externo-dorsal rays long and very slender, about midway between dorsal ray and postero-lateral ray. Postero-lateral and medio-lateral rays close together, arising from a common trunk, and extending almost to the margin of the bursa. Externo-lateral ray stout, curving sharply away from other lateral rays in its distal third, and ending at some distance from the bursal margin. Latero-ventral and ventro-ventral rays in contact for their whole length, curved forward, and ending at some distance from the bursal margin. These rays are much more slender than the lateral rays, but much thicker than the dorsal ray. Their length is only about half that of the externo-lateral and medio-lateral pair. Bosses numerous and small, occupying the portion of the bursa from near the ventral margin to the externo-lateral and medio-lateral pair of rays. Spicules (figs. 4–5) deep brownish red in color, 0.65 to 1.05 mm. long, united for the greater part of their length, and showing distinct striations on the proximal half. Tip of spicule curved ventrally, and ending in a membranous bulb. A pair of membranous wing-like expansions occur along the ventral side distally, ending in obtuse angles just proximal to the bulb. These membranous expansions have very fine markings as shown in figure 5. The body of the spicule ends in a finger-like process bent sharply dorsal, and ending on the dorsal margin of the bulb.

Female 16.5 to 20 mm. in length, with a maximum diameter of 180 to 220 μ at the vulva. Diameter abruptly but moderately reduced behind vulva. Head diameter 35 to 40 μ, exclusive of inflated cuticle: latter well developed, usually markedly asymmetrical, conspicuously striated, reaching a diameter of from 55 to 75 μ and extending back on the neck to a point 130 to 145 μ from the anterior end. Esophagus 450 to 600 μ in length. Tip of tail truncated and provided with the usual bristle-like process. Anus 105 to 115 μ from truncated end of body. Vulva a transverse slit 420 to 486 μ, almost exactly one-fourth length of body, from posterior end. Eggs long oval, measuring 160 to 180 μ by 80 to 90 μ, in various stages of development from morula to fully formed embryo when deposited.

Host.—Domestic rabbit, *Oryctolagus cuniculus.*

Location.—Duodenum.

Locality.—Houston, Texas.

Type.—Male, U.S.N.M., Helm. Coll. 7733; paratypes, males and females, U.S.N.M., Helm. Coll. 7734.

This species of *Nematodirus* seems to come closest to *filicollis*, which it resembles in general bursal characteristics, short spicules,

and position of vulva, and distinctly falls into the *filicollis* group as described by May (1920). The male differs, however, in the form of the tip of the spicules, in the shape of the bursa, in details of the arrangement and relative size of the bursal rays, in the number and arrangement of bosses, and in the thickness of the body. The female differs in its more slender body, the greater length of the tail, and in the more posterior position of the vulva. The latter characteristic is sufficient to distinguish the females from any other species of the genus. In this respect it approaches the genus *Mecistocirrus*, but does not approach it at all, as do some other species, in length of spicules, size of eggs, or presence of cervical papillae. This still further bears out May's (1920) contention that *Mecistocirrus* is not justifiably separated from *Nematodirus*.

OBELISCUS CUNICULI Graybill (1923).

Plate 2, figs. 6–11.

Since the original draft of this paper was written, the description of this worm by Graybill (1923), as a new genus and species, has appeared. It seems desirable, however, to add a few details to Graybill's description.

The worms are relatively large and robust for Trichostrongylids. Graybill describes them as whitish in color with some dark streaking due to the color of the intestine, but when living, in a freshly opened stomach, the worms are blood red in color. The longitudinal cuticular ridges vary in number from 16 to 26 in males and from 36 to 40 in females. These ridges are broken by transverse indentations at intervals of about 200 μ in the anterior portion of the female, and at somewhat shorter and more irregular intervals in the male. Extremely fine and inconspicuous transverse striations are present, most evident in the region of the vulva and on the tail of the female. The nerve ring crosses the esophagus a little anterior to the middle of its length.

The bursa (fig. 7), as mentioned by Graybill, consists of two large rounded lateral lobes, separated from each other dorsally by a relatively small dorsal lobe. At the obtuse angles formed where the ventral rays on the one hand, and the medio and postero lateral rays on the other, terminate near their margins, the bursal lobes have a maximum width of about 400 to 450 μ, while their maximum length, measured to the point where the externo-lateral ray terminates, is about 500 to 600 μ. The entire ventral surface of the bursa, except a fluted margin about 40 μ in width, is thickly covered with dew-drop-like bosses, giving the bursa a beautifully sculptured appearance. The ventro-ventral ray is smaller than any of the other rays in the lateral lobes except the externo-dorsal. The latero-

ventral ray is the largest of all. It is very stout basally and runs nearly parallel with the externo-lateral for about half its length, being widely separated from the ventro-ventral. The distal half, which tapers markedly, performs a wide sweeping curve forward until it comes very near to the ventro-ventral at the inner limit of the fluted bursal margin. At this point it bends outward again, so that the tips of the two ventral rays come to lie parallel in the fluted margin of the bursa, in an obtuse angle formed in the bursa at this point, directly opposite a similar obtuse angle formed where the medio- and postero-lateral rays terminate. These latter two rays are of moderate size, approximately equal, parallel, and curving dorsally. The externo-lateral ray is much larger than the other lateral rays, curves toward the ventral rays, and terminates in a sharply constricted finger-like tip at a point on the margin of the bursa about midway between the ventral and the other lateral rays. The small but stout externo-dorsal ray curves dorsally and terminates in the margin of the bursa about midway between the tips of the postero and medio-lateral rays and the junction of dorsal and lateral lobes.

The small dorsal lobe (fig. 8) is of very peculiar structure. It is overlapped, as Graybill has pointed out, by the lateral lobes, and is sharply marked off from them. It is supported by a single dorsal ray which forks distally into two bifurcated tips. Near the middle of its length a pair of branches are given off which curve ventrally, pass through a minute foramen, and enter a vesicular swelling as in *Cooperia.* Ventral to this swelling there is an additional membranous flap, supported by a pair of very minute, delicate parallel rays.

In some of the specimens measured the spicules (figs. 9–10) are considerably larger than those measured by Graybill, a number of them varying between 500 and 540 μ in length with a lateral diameter of 50 μ. Although the chitinous portion of the spicules is cleft distally, and terminates in a dorsal and a ventral hook, the spicules can not be said to be cleft, since these parts are connected by a membrane as shown in figures 9 and 10. The ventral hook is the larger and coarser, bending in a medioventral direction; the dorsal hook bends dorsally, laterally, and then distally, ending in a slender point. The membranous expansions at the distal ends of the spicules extend beyond the chitinous hooks.

A few of the females reach a length of 20 mm. Graybill gives the maximum length as 18.5 mm. He records the maximum width of one specimen as 546 μ, but in the Texas specimens the greatest width, of about a dozen specimens measured, was 400 μ, just anterior to the vulva. At this point there is a marked reduction in

diameter to from 305 to 340 μ. The diameter of the head anteriorly is only 80 μ, but 110 μ from the anterior end it has widened out to 150 μ. Graybill gives the diameter of the head as 119 μ. The vulva, guarded by a pair of inconspicuous lips, is situated about one-fifth the length of the body (3.6 to 4.5 mm.) from the posterior end, its location being readily recognized by the abrupt diminution in diameter of the body and the angular bending of the body at this point. The vagina is very short, joining the divergent ovijectors almost immediately. The muscular portions of the ovijectors can hold four or five eggs apiece; there is no well-marked sphincter between the muscular and nonmuscular portions, but a very strong sphincter separates the nonmuscular portion from the uterus. The terminal portion of the uterus is also muscular, and can contract so that only one egg at a time can reach the sphincter. The eggs in the Texas specimens measure 80 to 92 μ by 56 to 64 μ, whereas Graybill records measurements of 76 to 86 μ by 44 to 45 μ in the New Jersey specimens.

In spite of a number of slight discrepancies in the descriptions and measurements of the Texas and New Jersey specimens, it is very unlikely that more than one species is represented. My measurements were made from living narcotized worms, whereas Graybill's may have been made from preserved and prepared specimens, which would account for some of the differences.

When present in considerable numbers this worm produces a very marked erosion and ulceration of the stomach wall. The worms are found adhering firmly to the mucous membranes, and in some instances seem to have their heads buried deeply in the wall. In most of the rabbits examined only from one to five or six worms were found, but in one specimen about 50 adult worms and a number of immature specimens were found. Part of the material described above has been deposited in the Helminthological Collections of the U. S. National Museum, Nos. 7735 and 7736.

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1923. A New Genus of Nematodes from the Domestic Rabbit. Parasit., vol. 15, pp. 340–342, pl. 11.

May, H. G.:

1920. Observations on the Nematode genus Nematodirus with Descriptions of new Species. Proc. U. S. Nat. Mus., vol. 58, pp. 577–588, pls. 29–35

Ransom, B. H.:

1911. Two New Species of Parasitic Nematodes. Proc. U. S. Nat. Mus., vol. 41, pp. 363–369

EXPLANATIONS OF PLATES.

a.—anus.
a. d. l.—accessory dorsal lobe.
a. d. v.—accessory dorsal ray.
a. ov.—ascending oviduct.
d.—dorsal ray.
d. h.—dorsal hook.
d. l.—dorsal lobe.
d. v.—ventral branch of dorsal ray.
e. d.—externo-dorsal ray.
e. l.—externo-lateral ray.
l. v.—latero-ventral ray.
m. l.—medio-lateral ray.
m. ovij.—muscular portion of ovijector.
n. m. ovij.—non-muscular portion of ovijector.
oe.—esophagus.
p. l.—postero-lateral ray.
s.—sphincter of ovijector.
u.—uterus.
v.—vulva.
va.—vagina.
v. h.—ventral hook.
v. l.—ventral lobe.
v. s.—vesicular swelling under dorsal lobe.
v. v.—ventro-ventral ray.

PLATE 1.

FIG. 1.—*Trichostrongylus calcaratus.* Posterior end of young male, showing bulb-like expansion of larval cuticle, with developing bursa inside.

2–5.—*Nematodirus leporis*, new species. 2, adult worms, entire. 3, bursa, from left side. 4, spicules, entire, from left side. 5, tip of spicules, from left side.

PLATE 2.

FIGS. 6–11.—*Obeliscus cuniculi.* 6, adult worms, entire. 7, bursa, dorsal view. 8, dorsal lobe and accessory parts, from ventral side. 9, spicule, entire, lateral view. 10, Distal portion of spicule, dorsal view, slightly medial. 11, Vulval region of female, showing ovijectors.

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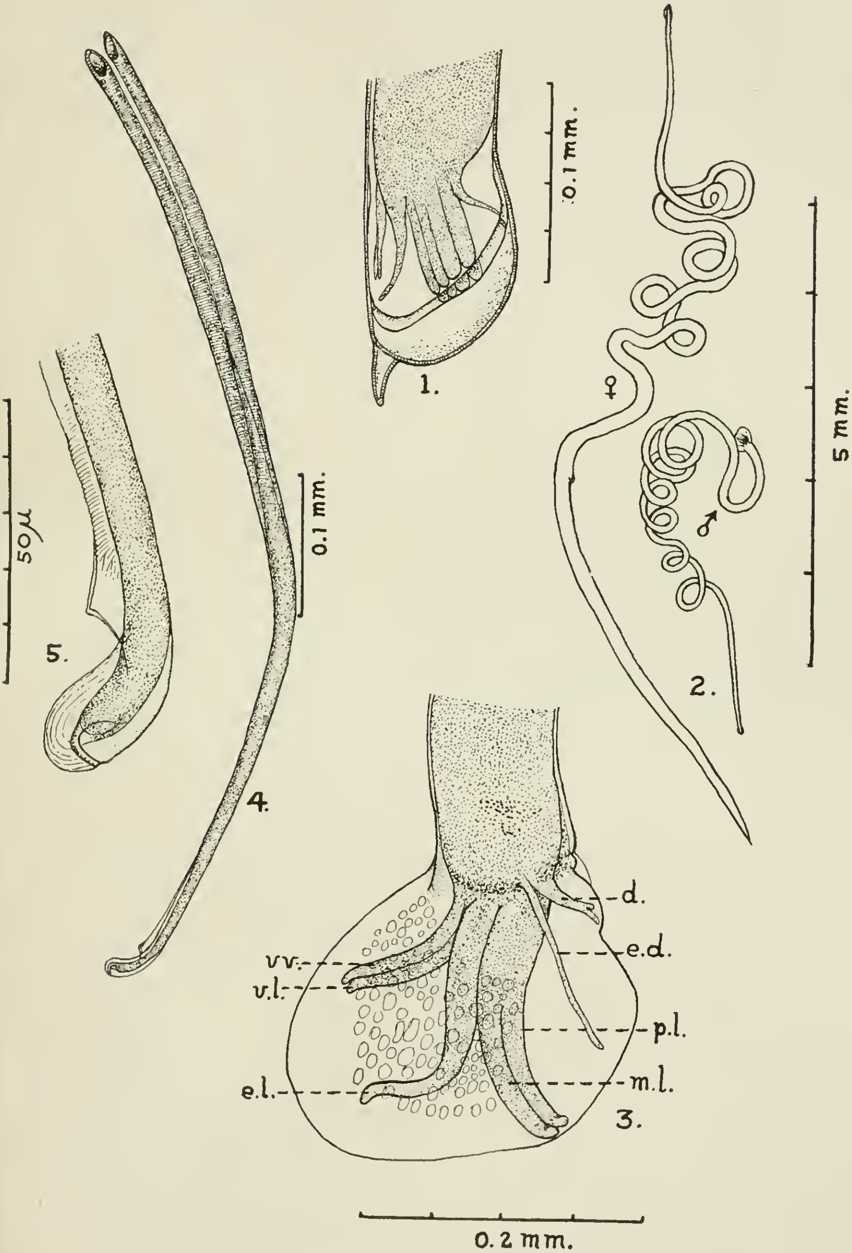
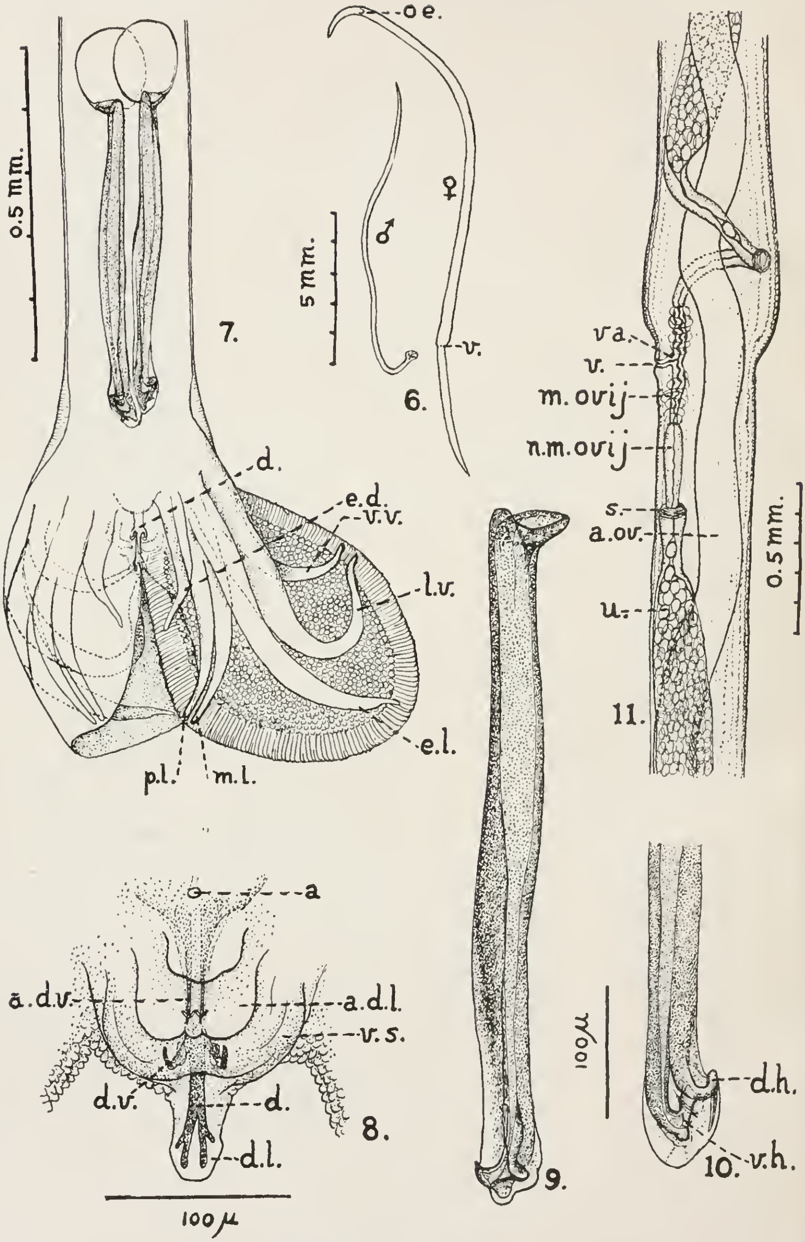


TRICHOSTRONGYLUS CALCARATUS AND NEMATODIRUS LEPORIS

FOR EXPLANATION OF PLATE SEE PAGE 6



OBELISCUS CUNICULI

FOR EXPLANATION OF PLATE SEE PAGE 6

ILLUSTRATIONS OF UNFIGURED TYPES OF SHELLS IN THE COLLECTION OF THE UNITED STATES NATIONAL MUSEUM

By William Healey Dall

Honorary Curator of Mollusks, United States National Museum

In past years it has happened that it had been advisable to print preliminary diagnoses of new species in order that established names might be used in reports, or for other reasons.

As opportunity offered, drawings were secured of these species and put aside until publication could be made.

The present paper collects together a large number of these figures. In addition to the figures of types, a few figures of species elsewhere inadequately illustrated, or which are figured in publications difficult of access, have been included.

The earlier of these drawings were made by the late Dr. J. C. McConnell, whose work of this kind has never been surpassed. The figures on plate 9, 19 to 26, and a few scattered ones on other plates are by him, and form probably the final publication of any of his work. Plates 1 to 8, 10 to 14, and 17 to 18 are from photographs artistically retouched by Mrs. E. B. Decker. Plates 27 to 36 are chiefly from drawings by Miss Evelyn Mitchell. Plates 15 and 16 are from untouched photographs by Prof. F. W. Kelsey, of San Diego.

For convenience of reference the species are arranged in alphabetical order, and an index of genera referred to is supplied.

A large proportion of the species included are from the northern waters of the Pacific, from the seas about Japan, northward and eastward to the northwest coast of North America. Nearly two hundred species are illustrated, and it is believed the student of these faunas will find the paper useful.

No. 2554.—Proceedings U. S. National Museum, Vol. 66, Art. 17.
20001—25——1

ACILA CASTRENSIS Hinds

Plate 9, fig. 5

Nucula castrensis HINDS, Proc. Zool. Soc. London, 1843, p. 98; Voy. of the *Sulphur*, Zool., Moll., p. 61, 1844.

Puget Sound. U. S. Nat. Mus. Cat. No. 106861.

ACMAEA DIGITALIS Eschscholtz

Plates 15 and 16

Acmaea digitalis ESCHSCHOLTZ, Zool. Atlas, pt. 5, p. 20, 1833.

Southern California. Photographed by Prof. F. W. Kelsey, San Diego.

AGATHOTOMA QUENTINENSIS Dall

Plate 8, fig. 1

Cytharella (*Agathotoma*) *quentinensis* DALL, West Amer. Scientist, San Diego, vol. 19, No. 3, p. 21, 1921.

Pliocene (?) of San Quentin Bay, Lower California. U. S. Nat. Mus. Cat. No. 333134.

ALIGENA NUCEA Dall

Plate 28, fig. 2

Aligena nucea DALL, Proc. U. S. Nat. Mus., vol. 45, p. 597, 1913.

Gulf of California. U. S. Nat. Mus. Cat. No. 267149.

AMPHISSA (COSMIOCONCHA) PALMERI Dall

Plate 21, fig. 8

Amphissa (*Cosmioconcha*) *palmeri* DALL, Proc. U. S. Nat. Mus., vol. 45, No. 2002, p. 589, 1913.

Head of the Gulf of California. U. S. Nat. Mus. Cat. No. 96720.

AMPHISSA (COSMIOCONCHA) PARVULA Dall

Plate 21, fig. 1

Amphissa (*Cosmioconcha*) *parvula* DALL, Proc. U. S. Nat. Mus., vol. 45, No. 2002, p. 590, 1913.

Off La Paz Bay, Gulf of California, in 112 fathoms. U. S. Nat. Mus. Cat. No. 211029.

AMPHISSA (COSMIOCONCHA) PERGRACILIS Dall

Plate 21, fig. 9

Amphissa (*Cosmioconcha*) *pergracilis* DALL, Proc. U. S. Nat. Mus., vol. 45, p. 590, 1913.

Off Cape Lobos, Gulf of California, in 58 fathoms. U. S. Nat. Mus. Cat. No. 211030.

ANATINA (RAETINA) INDICA Dall

Plate 20, fig. 2

Racta (*Raetina*) *indica* DALL, Trans. Wagner Inst. Sci. Phila., vol. 3, p. 882, 1898.

Bombay. U. S. Nat. Mus. Cat. No. 90276.

ANCISTROLEPIS BERINGIANUS Dall

Plate 7, fig. 1

Ancistrolepis beringiannus DALL, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 313, 1919.

Bering Sea, off Staritchkoff Island, in 58 fathoms. U. S. Nat. Mus. Cat. No. 205401.

ANCISTROLEPIS CALIFORNICUS Dall

Plate 3, fig. 9

Ancistrolepis californicus DALL, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 313, 1919.

Cortez Bank, off San Diego, Cal., in 984 fathoms. U. S. Nat. Mus. Cat. No. 122667.

ANCISTROLEPIS DAMON Dall

Plate 34, fig. 5

Chrysodomus (*Ancistrolepis*) *damon* DALL, Smithsonian Misc. Coll., vol. 50, p. 157, 1907.

South coast of Yesso, Japan, in 175 fathoms. U. S. Nat. Mus. Cat. No. 110474.

ANCISTROLEPIS DECORA, new species

Plate 35, fig. 10

Shell of moderate size, white under an olivaceous furfuraceous periostracum, with six somewhat turrited whorls exclusive of the (lost) nucleus; the periostracum shows projecting hairs at the intersections of the reticulate sculpture; the upper whorls are a good deal eroded in the type specimen; suture distinct, narrow, deep, but not channelled; spiral sculpture of a prominent strong cord at the shoulder, another, somewhat smaller, a little way in front of the suture, and numerous small threads with equal or wider interspaces, over the general surface; axial sculpture only of rather prominent and widely spaced incremental lines forming a minute reticulation with the spirals; aperture ample, outer lip thin, body with a thin wash of enamel, pillar very short, wrinkled over a well marked siphonal fasciole; canal hardly differentiated from the aperture; operculum normal, height 58; diameter, 34 mm. U. S. Nat. Mus. Cat. No. 110775.

Dredged in the Japan Sea at station 4991, in 325 fathoms, mud, by the United States Bureau of Fisheries steamer *Albatross*.

ANCISTROLEPIS GRAMMATUS Dall

Plate 30, fig. 8

Chrysodomus (*Ancistrolepis*) *grammatus* DALL, Smithsonian Misc. Coll., vol. 50, p. 158, 1907.

Sugaru Strait, Japan, in 300 fathoms. U. S. Nat. Mus. Cat. No. 110472.

ANCISTROLEPIS OKHOTENSIS, new species

Plate 30, fig. 1

Shell of moderate size, white under a velvety grey periostracum, with seven well rounded whorls exclusive of the (eroded) nucleus; suture deep and very narrow; axial sculpture of incremental lines, indicated by regularly spaced lamellae of the periostracum; spiral sculpture of fasciculated fine threads, with subequal intervals between the fascicles, also spirally threaded; aperture amply rounded, outer lip thin, not reflected, body erased, pillar short, callous, concavely arcuate, shorter than the aperture, distally twisted; base imperforate; operculum normal to the genus; height of shell, 47; of last whorl, 33; maximum diameter, 28 mm. U. S. Nat. Mus. Cat. No. 110777.

Dredged by the United States Bureau of Fisheries steamer *Albatross* at station 5022, off Sakhalin Island, in 109 fathoms, mud, bottom temperature 30° 1 F.

ANTIPLANES BULIMOIDES Dall

Plate 31, fig. 2

Antiplanes bulimoides Dall, Proc. U. S. Nat. Mus., vol. 56, p. 34, 1919.

Bowers Bank, Bering Sea, in 344 fathoms. U. S. Nat. Mus. Cat. No. 111051.

ANTIPLANES PIONA Dall

Plate 21, fig. 5

Antiplanes piona Dall, Proc. U. S. Nat. Mus., vol. 24, p. 514, 1902.

Southwestern Bering Sea. U. S. Nat. Mus. Cat. No. 109179.

ANTIPLANES THALAEA Dall

Plate 22, fig. 1

Pleurotoma (*Antiplanes*) *thalaea* Dall, Proc. U. S. Nat. Mus., vol. 24, p. 514, 1902.

Off San Luis Obispo, California, in 252 fathoms. U. S. Nat Mus. Cat. No. 122568.

ANTIPLANES YESSOENSIS, new species

Plate 21, fig. 3

Shell acute, solid, olivaceous, with a polished periostracum and seven whorls exclusive of the (lost) nucleus; suture closely appressed and constricted; axial sculpture of inconspicuous incremental lines; spiral sculpture of an obscure furrow in front of the anal fasciole, and feeble threading on the base which becomes stronger on the canal; there are also irregular markings which may be due to shrinkage of the periostracum; anal sulcus wide and shallow; outer lip thin sharp and arcuately produced; body erased, pillar attenuated, gyrate, the axis almost pervious; aperture rounded ovate, canal distinct, slightly recurved; height of shell, 38; of last whorl, 23; diameter, 14 mm. U. S. Nat. Mus. Cat. No. 111053.

Dredged by the United States Bureau of Fisheries steamer *Albatross* at station 5036, in 464 fathoms, mud, off the south coast of Yesso (Hokkaido), bottom temperature 37.9° F.

ARCA (NOETIA) MACDONALDI Dall

Plate 17, fig. 9

Arca (*Noetia*) *macdonaldi* DALL, Smithsonian Misc. Coll., vol. 59, p. 9, 1912.
Later Tertiary of Costa Rica. U. S. Nat. Mus. Cat. No. 214344.

ARCA (SCAPHARCA) PITTIERI Dall

Plate 17, fig. 7

Arca (*Scapharca*) *pittieri* DALL, Smithsonian Misc. Coll., vol. 59, p. 9, 1912.
Later Tertiary of the Canal Zone, Panama. U. S. Nat. Mus. Cat. No. 214343.

ASTRAEA PERSICA Dall

Plate 35, figs. 4, 6

Astraea persica DALL, Smithsonian Misc. Coll., vol. 56, p. 167, 1907.
Off Kagoshima Bay, Japan, in 103 fathoms. U. S. Nat. Mus. Cat. No. 110507.

Genus BASILISSA Watson

Subgenus ORECTOSPIRA, new subgenus

BASILISSA (ORECTOSPIRA) BABELICA Dall

Plate 32, figs. 8, 12

Basilissa babelica DALL, Smithsonian Misc. Coll., vol. 50, p. 168, 1907.
Dredged by the United States Bureau of Fisheries steamer *Albatross* off Hondo, Japan, at station 4973, in 600 fathoms, gravel, bottom temperature 39.8° F. Height of shell, 37 mm.

Watson named no type for his genus and I select his first species *B. lampra.* The present species differs from the typical form by the absence of the sinus where the outer lip joins the body, the elevation of the spire and in other minor features. It is possible that Watson's *B. superba* may belong in this subgenus.

BERINGIUS INDENTATUS Dall

Plate 7, fig. 3

Beringius indentatus DALL, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 312, 1919.
Bering Sea, off the Khudubine Islands, in 53 fathoms. U. S. Nat. Mus. Cat. No. 213318.

BERINGIUS MALLEATUS Dall

Plate 6, fig. 5

Strombella malleata DALL, Proc. U. S. Nat. Mus., vol. 7, p. 525, 1884.
Point Barrow, Alaska. U. S. Nat. Mus. Cat. No. 15170.

BERINGIUS STIMPSONI Gould

Plate 7, fig. 2

Buccinum stimpsoni GOULD, Proc. Boston Soc. Nat. Hist., vol. 7, p. 325, Sept. 1860.

Arikamcheche Island, Bering Strait. U. S. Nat. Mus. Cat. No. 225469.

BOLMA BARTSCHI Dall

Plate 36, fig. 9

Bolma bartschi DALL, Proc. U. S. Nat. Mus., vol. 45, p. 591, 1913.

Off Dowarra Island, near Ternate, Molucca Passage, East Indies, in 205 fathoms. U. S. Nat. Mus. Cat. No. 214444.

BOREOSCALA GREENLANDICA Perry

Plate 22, fig. 2

Scalaria greenlandica PERRY, Conchology, pl. 28, fig. 8, 1811.

Cape Espenberg, Arctic Ocean. U. S. Nat. Mus. Cat. No. 122546.

BORSONELLA CALLICESTA Dall

Plate 21, fig. 10

Pleurotoma callicesta DALL, Proc. U. S. Nat. Mus., vol. 24, p. 515, Mar. 1902.

Dredged off Acapulco, Mexico, by the United States Bureau of Fisheries steamer *Albatross* at station 3418, in 660 fathoms, mud, bottom temperature 39° F.

The apex, as in most of these abyssal species, is eroded; the shell remaining measures 20 mm. in length. The ridge on the pillar which is characteristic of the genus *Borsonella* is not visible from the aperture, but half a whorl back is evident.

BUCCINUM ACUTISPIRATUM Dall

Plate 33, fig. 8

Buccinum acutispiratum DALL, Smithsonian Misc. Coll., vol. 50, p. 146, 1907.

Sea of Japan, in 390 fathoms. U. S. Nat. Mus. Cat. No. 110525.

BUCCINUM ANIWANUM Dall

Plate 30, fig. 6

Buccinum aniwanum DALL, Smithsonian Misc. Coll., vol. 50, p. 147, 1907.

Aniwa Bay, at the south end of Sakhalin Island, in 40 fathoms. U. S. Nat. Mus. Cat. No. 110528.

BUCCINUM BOMBYCINUM Dall

Plate 30, fig. 7

Buccinum bombycinum DALL, Smithsonian Misc. Coll., vol. 50, p. 149, 1907.

Off east coast of Sakhalin Island, in 29 fathoms. U. S. Nat. Mus. Cat. No. 110531.

BUCCINUM CASTANEUM FLUCTUATUM Dall

Plate 5, fig. 3

Buccinum castaneum, var. *fluctuatum* DALL, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 327, 1919.

Off St. George Island, Bering Sea, in 30 fathoms. U. S. Nat. Mus. Cat. No. 217152.

BUCCINUM CASTANEUM INCISULUM Dall

Plate 3, fig. 7

Buccinum castaneum, var. *incisulum* DALL, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 237, 1919.

Unimak Pass, Aleutian Islands. U. S. Nat. Mus. Cat. No. 213159.

BUCCINUM CHARTIUM Dall

Plate 6, fig. 2

Buccinum chartium DALL, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 325, 1919.

Off Honshu Island, Japan Sea, in 260 fathoms. U. S. Nat. Mus. Cat. No. 224198.

BUCCINUM CNISMATOPLEURA Dall

Plate 4, fig. 4

Buccinum angulosum, var. *cnismatopleura* DALL, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 328, 1919.

Point Barrow, Arctic Ocean, Alaska. U. S. Nat. Mus. Cat. No. 332759.

BUCCINUM ECTOMOCYMA Dall

Plate 33, fig. 9

Buccinum ectomocyma DALL, Smithsonian Misc. Coll., vol. 50, p. 148, 1907.

East coast of Sakhalin in 75 fathoms. U. S. Nat. Mus. Cat. No. 110530.

BUCCINUM EPISTOMIUM Dall

Plate 31, fig. 1

Buccinum epistomium DALL, Smithsonian Misc. Coll., vol. 50, p. 144, 1907.

Off Cape Rollin, Simushir Island, Kuril Islands, in 229 fathoms. U. S. Nat. Mus. Cat. No. 110519.

BUCCINUM LIMNOIDEUM Dall

Plate 32, fig. 7

Buccinum limnoideum DALL, Smithsonian Misc. Coll., vol. 50, p. 149, 1907.

Off Hakodate, Japan, in 47 fathoms. U. S. Nat. Mus. Cat. No. 110532.

BUCCINUM NIPPONENSE Dall

Plate 35, fig. 9

Buccinum nipponense DALL, Smithsonian Misc. Coll., vol. 50, p. 142, 1907.

South coast of Nippon, Japan, in 175 fathoms. U. S. Nat. Mus. Cat. No. 110515.

BUCCINUM OPISTHOPLECTUM Dall

Plate 33, fig. 4

Buccinum opisthoplectum DALL, Smithsonian Misc. Coll., vol. 50, p. 142, 1907.
Japan Sea, in 86 fathoms. U. S. Nat. Mus. Cat. No. 110514.

BUCCINUM PEMPHIGUS Dall

Plate 5, fig. 2; plate 31, fig. 7

Buccinum pemphigus DALL, Smithsonian Misc. Coll., vol. 50, p. 151, 1907.
Off Dalnoi Point, Kamchatka, in 682 fathoms. U. S. Nat. Mus. Cat. No. 110537.

BUCCINUM PHYSEMATUM Dall

Plate 4, fig. 5

Buccinum physematum DALL, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 328, 1919.
Bering Sea, in about 30 fathoms. U. S. Nat. Mus. Cat. No. 122555.

BUCCINUM PLANETICUM Dall

Plate 5, fig. 1

Buccinum planeticum DALL, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 326, 1919.
Bering Sea, southwest of Hagmeister Island, in 23 fathoms. U. S. Nat. Mus. Cat. No. 223098.

BUCCINUM POLIUM Dall

Plate 33, fig. 1

Buccinum polium DALL, Smithsonian Misc. Coll., vol. 50, p. 145, 1907.
Aniwa Bay, Sakhalin Island, in 42 fathoms. U. S. Nat. Mus. Cat. No. 110523.

BUCCINUM ROSSICUM Dall

Plate 31, fig. 5

Buccinum rossicum DALL, Smithsonian Misc. Coll., vol. 50, p. 150, 1907.
Aniwa Bay, Sakhalin Island, in 42 fathoms. U. S. Nat. Mus. Cat. No. 110546.

BUCCINUM SAKHALINENSE Dall

Plate 30, fig. 5

Buccinum sakhalinense DALL, Smithsonian Misc. Coll., vol. 50, p. 148, 1907.
Aniwa Bay, Sakhalin Island. U. S. Nat. Mus. Cat. No. 110529.

BUCCINUM SOLENUM Dall

Plate 4, fig. 1

Buccinum solenum DALL, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 325, 1919.
Off Nunivak Island, Bering Sea, in 36 fathoms. U. S. Nat. Mus. Cat. No. 221283.

BUCCINUM SURUGANUM Dall

Plate 33, fig. 5

Buccinum suruganum DALL, Smithsonian Misc. Coll., vol. 50, p. 146, 1907.
Suruga Gulf, south coast of Nippon, Japan, in 29 fathoms. U. S. Nat. Mus. Cat. No. 110526.

BUCCINUM TENUE LYPERUM Dall

Plate 3, fig. 8

Buccinum tenue, var. *lyperum* DALL, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 324, 1919.

Eastern coast of Kamchatka, in 100 fathoms. U. S. Nat. Mus. Cat. No. 225611.

BUCCINUM TENUE RHODIUM Dall

Plate 6, fig. 1

Buccinum tenue rhodium DALL, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 324, 1919.

Bering Sea, at Plover Bay, Eastern Siberia. U. S. Nat. Mus. Cat. No. 224069.

BUCCINUM ZELOTES Dall

Plate 32, fig. 5

Buccinum zelotes DALL, Smithsonian Misc. Coll., vol. 50, p. 141, 1907.

Sea of Japan in 114 fathoms. U. S. Nat. Mus. Cat. No. 110513.

CADULUS CALIFORNICUS Pilsbry and Sharp

Plate 9, fig. 3

Cadulus (Gadila) californicus PILSBRY and SHARP, Man. Conch., vol. 17, p. 180, 1898.

Clarence Strait, Alaska. U. S. Nat. Mus. Cat. No. 122599.

CALLIOSTOMA NEPHELOIDE Dall

Plate 24, figs. 2, 3

Calliostoma nepheloide DALL, Proc. U. S. Nat. Mus., vol. 45, p. 592, 1913.

Panama Bay, in 47 fathoms. U. S. Nat. Mus. Cat. No. 96637.

CALLIOSTOMA TRICOLOR Gabb

Plate 9, fig. 6

Calliostoma tricolor GABB, Proc. Cal. Acad. Sci., vol. 3, p. 186, 1865.

Santa Cruz, Monterey Bay, California. U. S. Nat. Mus. Cat. No. 32508.

CHRYSODOMUS (SULCOSIPHO?) ADELPHICUS Dall

Plate 35, fig. 8

Chrysodomus adelphicus DALL, Smithsonian Misc. Coll., vol. 50, p. 155, 1907.

Yokohama, Japan. U. S. Nat. Mus. Cat. No. 109247.

CHRYSODOMUS EULIMATUS Dall

Plate 14, fig. 1; plate 34, fig. 3

Chrysodomus eulimatus DALL, Smithsonian Misc. Coll., vol. 50, No. 1727, p. 156, 1907; Proc. U. S. Nat. Mus., vol. 45, No. 2002, p. 587, 1913.

Aniwa Bay, Sakhalin Island, U. S. Nat. Mus. Cat. No. 110541. The specimen figured on Plate 34 is the type originally described, but that on plate 14 represents the adult shell.

CHRYSODOMUS NUCEUS Dall

Plate 4, fig. 3

Chrysodomus nuceus Dall, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 322, 1919.
Cook's Inlet, Alaska. U. S. Nat. Mus. Cat. No. 151429.

CHRYSODOMUS PRIBILOFFENSIS Dall

Plate 7, fig. 4

Chrysodomus pribiloffensis Dall, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 323, 1919.
Bering Sea, off the Pribilof Islands in 50 to 100 fathoms. U. S. Nat. Mus Cat. No. 224085.

CHRYSODOMUS SATURUS TABULARIS Dall

Plate 4, fig. 6

Chrysodomus saturus Martyn, var. *tabularis* Dall, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 323, 1919.
Bering Sea, near Nunivak Island. U. S. Nat. Mus. Cat. No. 31350.

CHRYSODOMUS SMIRNIUS Dall

Plate 4, fig. 2

Chrysodomus smirnius Dall, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 322, 1919.
Straits of Fuca, in 114 fathoms. U. S. Nat. Mus. Cat. No. 130418.

CHRYSODOMUS VINOSUS Dall

Plate 6, fig. 3

Chrysodomus vinosus Dall, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 323, 1919.
Avacha Bay, Kamchatka, in 16 fathoms. U. S. Nat. Mus. Cat. No. 225608.

CIRSOTREMA PLEXIS, new species

Plate 21, figs. 12, 12*a*

Shell slender, whitish, with 10 moderately rounded whorls exclusive of the (lost) nucleus; with five or six irregularly placed major varices, and numerous minor ones which bridge by slender projections the invisible suture; on the last whorl there are 20 minor and 3 major varices; the spiral sculpture, imbedded in the minor varical sculpture is obscurely indicated as a cord in front of the suture, 4 obscure ones, which form projections on the major varices, between the former and the base which is indicated by a deep furrow in front of which is a very strong cord around a marked concavity; both the furrow and the concavity are bridged by slender extensions of the minor varices; the minor varices are externally flattened and obliquely sculptured as indicated in figure 12*a*.; the axis is imperforate, the aperture circular, the final varix heavy and crenulated; height

of shell, 46; maximum diameter, 14mm. U. S. Nat. Mus. Cat. No. 110769.

Dredged by the United States Bureau of Fisheries Steamer *Albatross*, at station 3707, off Honshu Island, Japan, in 63 to 70 fathoms, volcanic sand.

This belongs to the group of *C. varicosum* Lamarck, to which many species have been inadvisably referred though discriminable by their minor sculpture.

COCCULINA JAPONICA Dall

Plate 26, figs. 3, 5

Cocculina japonica DALL, Smithsonian Misc. Coll., vol. 50, p. 169, 1907.

Off Sado Island, Japan, in 200 fathoms. U. S. Nat. Mus. Cat. No. 110544.

COCCULINA RHYSSA, new species

Plate 32, figs. 10, 11

Shell small, translucent white, ovate, with a nearly smooth flattened apical area with the protoconch showing as a small opaque white spot in the center; outside of this area the concentric sculpture rises as sharp-edged laminae, about 10 on the type specimen, with wider interspaces and their edges crenulated by the radial sculpture; the radial sculpture consists of numerous threads which do not divide distally and are separated by narrower interspaces; the interior of the shell is smooth and white; the apex is about one-third of the length from the anterior edge, both slopes are somewhat convex; the margin of the shell is very slightly crenulate by the radial sculpture; height of shell, 3; length 7.6; width 5 mm. U. S. Nat. Mus. Cat. No. 110782.

Dredged at station 3721, in 250 fathoms, off Hondo, Japan, bottom temperature 64° F. This is the first species of the genus to show pronounced sculpture.

COLUS (ANOMALOSIPHO) ADONIS Dall

Plate 1, fig. 8

Colus (*Aulacofusus*) *adonis* DALL, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 316, 1919.

Suruga Gulf, Japan, in 503 fathoms. U. S. Nat. Mus. Cat. No. 205212. Also found in Alaskan waters.

COLUS (LATISIPHO) APHELUS Dall

Plate 1, fig. 3

Chrysodomus aphelus DALL, Proc. U. S. Nat. Mus., vol. 12, 1889, p. 323.

Off Santa Barbara, California, in 414 fathoms. U. S. Nat. Mus. Cat. No. 206449.

COLUS (AULACOFUSUS) BARBARINUS Dall

Plate 2, fig. 5

Colus (*Aulacofusus*) *barbarinus* Dall, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 316, 1919.

Off Khudubine Island, Bering Sea, in 53 fathoms. U. S. Nat. Mus. Cat. No. 334438.

COLUS (AULACOFUSUS) BRISTOLENSIS Dall

Plate 2, fig. 8

Colus (*Aulacofusus*) *bristolensis* Dall, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 316, 1919.

Bristol Bay, Alaska, in 29½ fathoms. U. S. Nat. Mus. Cat. No. 213254.

COLUS (AULACOFUSUS) CAPPONIUS Dall

Plate 3, fig. 2

Colus (*Aulacofusus*) *capponius* Dall, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 317, 1919.

Bering Strait near Port Clarence, in about 30 fathoms. U. S. Nat. Mus. Cat. No. 108980.

COLUS (LATISIPHO) CLEMENTINUS Dall

Plate 2, fig. 9

Colus (*Latisipho*) *clementinus* Dall, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 321, 1919.

Between Santa Catalina and San Clemente Islands, Calif., in 654 fathoms. U. S. Nat. Mus. Cat. No. 208912.

COLUS (LATISIPHO) DALMASIUS Dall

Plate 1, fig. 9

Colus (*Latisipho*) *dalmasius* Dall, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 322, 1919.

Off British Columbia in 238 fathoms. U. S. Nat. Mus. Cat. No. 122631.

COLUS (AULACOFUSUS) DIMIDIATUS Dall

Plate 2, fig. 3

Aulacofusus (*Limatofusus*) *dimidiatus* Dall, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 319, 1919.

Off Tillamook Bay, Oreg., in 786 fathoms. U. S. Nat. Mus. Cat. No. 213338.

COLUS (LATISIPHO) ERRONES Dall

Plate 3, fig. 6

Colus (*Latisipho*) *errones* Dall, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 321, 1919.

Bering Sea. U. S. Nat. Mus. Cat. No. 122620.

COLUS (AULACOFUSUS) HALIDONUS Dall

Plate 1, fig. 12

Colus (*Aulacofusus*) *halidonus* DALL, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 318, 1919.

Off Destruction Island, coast of Washington, in 516 fathoms. U. S. Nat. Mus. Cat. No. 213250.

COLUS (AULACOFUSUS) HALIMERIS Dall

Plate 2, fig. 7

Aulacofusus (*Limatofusus*) *halimeris* DALL, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 320, 1919.

Eastern Passage, near the Stikine River, southeastern Alaska, in 70 fathoms. U. S. Nat. Mus. Cat. No. 207192.

COLUS (LIMATOFUSUS) MORDITUS Dall

Plate 1, fig. 1

Colus (*Limatofusus*) *morditus* DALL, Proc. U. S. Nat. Mus., vol. 56, p. 319, 1919.

Gulf of Georgia, British Columbia. U. S Nat. Mus. Cat. No. 222462.

COLUS (AULACOFUSUS) NOBILIS Dall

Plate 5, fig. 4

Colus (*Aulacofusus*) *nobilis* DALL, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 315, 1919.

Bering Sea near the Pribiloff Islands in 60 fathoms. U. S. Nat. Mus. Cat. No. 222983.

COLUS (AULACOFUSUS) OMBRONIUS Dall

Plate 3, fig 5

Colus (*Aulacofusus*) *ombronius* DALL, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 315, 1919.

Bering Sea, between Bristol Bay and the Pribiloff Islands in about 30 fathoms. U. S. Nat. Mus. Cat. No. 213239.

COLUS (AULACOFUSUS) PULCIUS Dall

Plate 3, fig. 1

Aulacofusus (*Limatofusus*) *pulcius* DALL, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 318, 1919.

Arctic Ocean. north of Bering Strait. in about 50 fathoms. U. S. Nat. Mus. Cat. No. 223799.

COLUS (AULACOFUSUS) ROSEUS Dall

Plate 26, fig. 2

Chrysodomus roseus DALL, Proc. Cal. Acad. Sci., vol. 7, p. 7, 1877.

Bristol Bay, Bering Sea, in 10 to 15 fathoms. U. S. Nat. Mus. Cat. No. 122664.

COLUS (AULACOFUSUS) SAPIUS Dall

Plate 2, fig. 10, plate 26, fig. 9

Colus (*Aulacofusus*) *sapius* DALL, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 317, 1919.

Southwest of Sitka, Alaska, in 1,569 fathoms. U. S. Nat. Mus. Cat. No. 122597.

COLUS (AULACOFUSUS) SEVERINUS Dall

Plate 1, fig. 11

Aulacofusus (*Limatofusus*) *severinus* DALL, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 320, 1919.

Monterey Bay, Calif., in 278 fathoms. U. S. Nat. Mus. Cat. No. 225225.

COLUS (LIMATOFUSUS) TIMETUS Dall

Plate 1, fig. 2

Colus (*Limatofusus*) *timetus* DALL, Proc. U. S. Nat. Mus., vol. 56, p. 318, 1919.

Unalaska, Aleutian Islands. U. S. Nat. Mus. Cat. No. 213337.

COLUS (AULACOFUSUS) TROMBINUS Dall

Plate 2, fig. 6

Aulacofusus (*Limatofusus*) *trombinus* DALL, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 321, 1919.

Off the Pribilof Islands, Bering Sea, in 36 fathoms. U. S. Nat. Mus., Cat. No. 213332.

COLUS (AULACOFUSUS) TROPHIUS Dall

Plate 1, fig. 10

Aulacofusus (*Limatofusus*) *trophius* DALL, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 319, 1919.

Off Sea Lion Rock, coast of Washington, in 685 fathoms. U. S. Nat. Mus., Cat. No. 122632.

CORALLIOPHILA SPINOSA, new species

Plate 36, figs. 5, 8

Shell dirty white, elevated, with a minute smooth nucleus of one, and eight subsequent whorls; suture obscure, appressed; spiral sculpture on the spire of a row of spines on the periphery, on the last whorl with an added row of smaller ones at the edge of the base; the last whorl carries about 10 subtriangular recurved peripheral spines; in front of the periphery and on the base are numerous small close scabrous threads; the axial sculpture is low, sublamellose imbricating and more or less irregular; aperture rounded, modified by the sculpture, the canal open, strongly recurved, the siphonal fasciole spinose with five or six old canals, and forming a narrow funicular umbilicus; height of shell, 38; maximum diameter, 25 mm. U. S. Nat. Mus. Cat. No. 111045.

Dredged by the United States Bureau of Fisheries steamer *Albatross* at station 3700, off Honshu Island, Japan, in 63 fathoms, volcanic sand.

This has the form of some of the *Murices* but the surface texture of *Coralliophila*, and its umbilical pit.

CORBICULA (CYRENODONAX) FORMOSANA Dall

Plate 29, fig. 3

Corbicula (*Cyrenodonax*) *formosana* DALL, Trans. Wagner Inst. Sci. Phila., vol. 3, p. 1450, footnote, 1903.

Mouth of Tamsui River, Formosa. U. S. Nat. Mus. Cat. No. 47964.

CORBICULA (CYANOCYCLAS) OLEANA Marshall

Plate 35, fig. 2

Corbicula (*Cyanocyclas*) *oleana* MARSHALL, Proc. U. S. Nat. Mus., vol. 66, No. 2552, p. 8, Nov. 3, 1924.

Collected by Don Severiano de Olea at the Arroyo de Malvin, Department of Montevideo, Uruguay. U. S. Nat. Mus. Cat. No. 109261.

Height of shell, 14; breadth, 13; diameter, 9 mm.

CORBULA MACDONALDI Dall

Plate 17, figs. 1, 3

Corbula macdonaldi DALL, Smithsonian Misc. Coll., vol. 59, No. 2, p. 3, Mar., 1912.

Pleistocene of the Canal Zone, Panama. U. S. Nat. Mus. Cat. No. 214358.

CRENELLA COLUMBIANA Dall

Plate 9, fig. 1

Crenella columbiana DALL, Bull. Nat. Hist. Soc. Brit. Col., No. 2, p. 4, 1897.

Nazan Bay, Atka Island, Aleutians, in 12 fathoms. U. S. Nat. Mus. Cat. No. 107641. A young shell.

CRYPTOMYA MAGNA Dall

Plate 13, figs. 3, 4

Cryptomya magna DALL, West Amer. Scientist, vol. 19, No. 2, p. 17, 1921.

Pliocene (?) of San Quentin Bay, Lower California. U. S. Nat. Mus. Cat. No. 333127.

CUMINGIA DENSILINEATA Dall

Plate 8, fig. 5, plate 11, fig. 2

Cumingia densilineata DALL, West Amer. Scientist, vol. 19, No. 3, p. 22, 1921.

Pliocene (?) of San Quentin Bay, Lower California. U. S. Nat. Mus. Cat. No. 333115.

CUSPIDARIA GLACIALIS Sars

Plate 20, fig. 4

Neaera glacialis G. O. SARS, Moll. Reg. Arct. Norv., p. 88, 1878.

Off San Diego, Calif., in deep water. U. S. Nat. Mus. Cat. No. 122587.

20001—25——3

CUSPIDARIA TROSAETES, new species

Plate 29, fig. 5

Shell large, thin, greyish, with a velvety periostracum, equivalve, inequilateral, inflated; beaks low, rather anterior; posterior end compressed, pointed, attenuated; anterior end evenly rounded; posterior dorsal slope descending, nearly straight, base roundly arcuated; hinge with an internal resilium inclined posteriorly, and a single long lateral tooth in the right valve; length of shell, 25; beaks before posterior end, 15; height, 16; diameter, 11 mm. U. S. Nat. Mus. Cat. No. 110770.

Dredged at station 4992, in the Japan Sea, in 325 fathoms, mud, by the United States Bureau of Fisheries steamer *Albatross*.

This belongs to the typical section of the genus, and is notable for its thick velvety periostracum.

CYMATIUM ADAIRENSE Dall

Plate 35, fig. 1

Cymatium adairense Dall, Nautilus, vol. 24, p. 33, 1910.
Off Adair Bay, Gulf of California. U. S. Nat. Mus. Cat. No. 214103.

DENTALIUM CROCINUM Dall

Plate 27, fig. 8

Dentalium crocinum Dall, Smithsonian Misc., Coll., vol. 50, p. 169, 1907.
Gulf of Tokio, Japan, in 88 fathoms. U. S. Nat. Mus. Cat. No. 110508.

EMARGINULA CHORISTES, new species

Plate 26, figs. 1, 4

Shell thin, very elevated, tapering to an acute apex, which stands vertically above the posterior margin; slit about one fifth of the length of the anterior convex slope, its fasciole narrow and inconspicuous; posterior slope beneath the curved apex, nearly vertical; color of the shell pale brownish; axial sculpture of about 16 major threads with from 3 to 7 (often alternated) smaller threads between them, closely reticulated by rather uniform small concentric threads; the sculpture is rounded rather than sharp or laminate; base ovate; height, 18; anteroposterior diameter, 17; transverse diameter, 12 mm. U. S. Nat. Mus. Cat. No. 110781.

Dredged in the Eastern Sea of Japan, in 361 fathoms, sand, at station 4917, by the United States Bureau of Fisheries steamer *Albatross*.

ERYCINA COLPOICA Dall

Plate 27, fig. 2

Erycina colpoica Dall, Proc. U. S. Nat. Mus., vol. 45, p. 596, 1913.
Gulf of California. U. S. Nat. Mus. Cat. No. 267403.

EUCALODIUM (ANISOSPIRA) ORCUTTI Dall

Plate 23, figs. 8, 11

Eucalodium (Anisospira) orcutti DALL, Nautilus, vol. 24, p. 34, July, 1910.
Oaxaca, Mexico. U. S. Nat. Mus. Cat. No. 212319.

EUSPIRA BAHAMENSIS, new species

Plate 9, fig. 2

Shell small, white, rather depressed, of three and a half well rounded whorls, the suture deep; surface smooth except for two or three weak spiral striae, directly in front of the suture and more or less obsolete on the later whorls; aperture ovate, narrow behind, outer lip sharp, inner lip nearly straight, not callous, but united by a layer of enamel over the body with the outer lip; umbilicus large, funicular, alt. 6.3; diameter, 8 mm. U. S. Nat. Mus. Cat. No. 107447.

Dredged by the United States Fish Commission at station 2324, on the Great Bahama Bank in 33 fathoms.

This is nearly the size of *Natica leptalea* Watson, but more depressed and with a much larger umbilicus.

EXILIA KELSEYI Dall

Plate 1, fig. 6

Tritonofusus (Plicifusus) kelseyi DALL, Proc. U. S. Nat. Mus., vol. 34, p. 249, 1908.
Off San Diego, Calif., in 124 to 359 fathoms (young) and in 50 fathoms (adult) by Prof. F. W. Kelsey. U. S. Nat. Mus. Cat. No. 224346.

FUSINUS DIMINUTUS Dall

Plate 2, fig. 1

Fusinus diminutus DALL, Nautilus, vol. 29, p. 56, 1915.
San Pedro Bay, Calif., beaches. U. S. Nat. Mus. Cat. No. 185958.

FUSINUS TRASKI Dall

Plate 3, fig. 4

Fusinus traski DALL, Nautilus, vol. 19, p. 54, 1915. (*Fusus rugosus* Trask, 1855, not of Lamarck, 1804).
San Pedro, Calif. U. S. Nat. Mus. Cat. No. 124761.

GALEODEA LEUCODOMA Dall

Plate 34, fig. 4

Galeodea leucodoma DALL, Smithsonian Misc. Coll., vol. 50, p. 166, 1907.
Off Kagoshima, Japan, in 391 fathoms. U. S. Nat. Mus. Cat. No. 110503.

GYRINOPSIS COWLITZI Dall

Plate 18, figs. 4, 6

Eocene of Washington, near the Cowlitz River, alt. 65 mm. U. S. Nat. Mus. Cat. No. 333539. Collected by Ralph Arnold.

ISCHNOCHITON CONSPICUA Carpenter

Plate 18, fig. 7

Ischnochiton (*Stenoplax*) *conspicua* Carpenter in Pilsbry, Man. Conch., vol. 14, p. 63, 1892.

Abnormal specimen with only six valves, collected by Hemphill. Photographed by Prof. F. W. Kelsey, San Diego, Calif.

LACUNA SOLIDULA Lovèn

Plate 34, fig. 2

Lacuna solidula Lovèn, Index Moll. Scand., p. 21, 1846.
Lacuna carinata Gould, Proc. Boston Soc. Nat. Hist., vol. 3, p. 75, 1848.

Neah Bay, Wash. U. S. Nat. Mus. Cat. No. 15530.

LACUNA UNIFASCIATA Carpenter

Plate 31, fig. 4

Lacuna unifasciata Carpenter, Proc. Zool. London, 1856, p. 205.

Monterey, Calif. U. S. Nat. Mus. Cat. No. 60675.

The color markings are not indicated on the figure.

LIMA HAMLINI Dall

Plate 29, fig. 6

Lima hamlini Dall, Nautilus, vol. 14, p. 16, 1900.

Pliocene clays of Los Angeles, Calif. Collection of R. E. C. Stearns.

LIOCYMA ANIWANA Dall

Plate 28, figs. 4, 6; plate 29, figs. 1, 2

Liocyma aniwana Dall, Smithsonian Misc. Coll., vol. 50, No. 1727, p. 172, July, 1907.

Dredged by the United States Bureau of Fisheries steamer *Albatross*, in Aniwa Bay, Sakhalin Island, Japan, in 43 fathoms, muddy bottom, at station 5013.

Related to *L. beckii* Dall, but coarser, more irregularly sculptured and of a dark yellow brown color. Length of the shell 24 mm. U. S. Nat. Mus. Cat. No. 110511.

LIOMESUS BISTRIATUS Dall

Plate 34, fig. 6

Liomesus bistriatus Dall, Smithsonian Misc. Coll., vol. 50, p. 165, 1907.

Off Hakodate, Japan, in 205 fathoms. U. S. Nat. Mus. Cat. No. 110500.

LIOTIA LURIDA Dall

Plate 36, fig. 3

Liotia lurida DALL, Proc. U. S. Nat. Mus., vol. 45, No. 2002, p. 590, June 11, 1913.

Collected at San Joseph Island, Gulf of California, on the beach by Dr. Paul Bartsch, in 1911. Diameter of shell 5 mm.

LITTORINA GRÖNLANDICA Menke

Plate 25, fig. 2

Littorina grönlandica MENKE, Synopsis, p. 45, 1830.

Middleton Island, Alaska. U. S. Nat. Mus. Cat. No. 206044.

This may perhaps be regarded as a variety of Menke's species.

LITTORINA SITKANA Philippi

Plate 25, fig. 7

Littorina sitkana PHILIPPI, Proc. Zool. Soc. London, for 1845, p. 140.

Sitka, Alaska. U. S. Nat. Mus. Cat. No. 206054.

LYONSIA MAGNIFICA Dall

Plate 23, fig. 2

Lyonsia magnifica DALL, Proc. U. S. Nat. Mus., vol. 45, p. 595, 1913.

Off Mazatlan, Mexico, in deep water. U. S. Nat. Mus. Cat. No. 266802.

MACOMA ACOLASTA Dall

Plate 8, figs. 2, 3

Macoma acolasta DALL, West Amer. Scientist, vol. 19, No. 3, p. 21, 1921.

Pliocene (?) of San Quentin Bay, Lower California. U. S. Nat. Mus. Cat. No. 333113.

MACTRA (MACTROTOMA) CALIFORNICA Conrad

Plate 20, fig. 1

Mactra californica CONRAD, Journ. Acad. Nat. Sci. Phila., vol. 7, p. 340, pl. 18, fig. 12, 1837.

San Diego, Calif. U. S. Nat. Mus. Cat. No. 46912.

MARGARITES ALBOLINEATUS E. A. Smith

Plate 23, figs. 3, 6

Valvatella albolineata SMITH, Proc. Malac. Soc. London, vol. 3, p. 206, fig. 2, 1898.

Attu Island, Alaska. U. S. Nat. Mus. Cat. No. 109463.

MARGARITES BERINGENSIS E. A. Smith

Plate 36, figs. 4, 6

Valvatella beringensis E. A. SMITH, Proc. Malac. Soc. London, vol. 3, p. 206, 1899.

Petrel Bank, Bering Sea. U. S. Nat. Mus. Cat. No. 111048.

MARGINELLA MACDONALDI Dall

Plate 17, figs. 4, 5

Marginella macdonaldi Dall, Smithsonian Misc. Coll., vol. 59, p. 7, 1912. Later Tertiary of Costa Rica. U. S. Nat. Mus. Cat. No. 214348.

MELANELLA MICANS BOREALIS Bartsch

Plate 9, fig. 4

Eulima micans Carpeter, Proc. Acad. Nat. Sci. Phila. for 1865, p. 63; Puget Sound.

Melanella micans borealis Bartsch, Proc. U. S. Nat. Mus., vol. 53, No. 2207, p. 305, pl. 35, fig. 7, Aug., 1917. Comox, B. C.

The specimen figured is from Kodiak, Alaska. U. S. Nat. Mus. Cat. No. 160084. Collected by W. H. Dall. This is the most northern locality yet known. The variety differs from the typical *M. micans* according to Bartsch by being constantly more slender.

MELANELLA RANDOLPHI Vanatta

Plate 9, fig. 7

Eulima randolphi Vanatta, Proc. Acad. Nat. Sci. Phila., for 1899, p. 256, pl. 11, figs. 13, 14, 1899. Unalaska, Alaska.

Melanella randolphi Bartsch, Proc. U. S. Nat. Mus., vol. 53, No. 2207, p. 312; pl. 37, fig. 4, Aleutian Islands to Puget Sound.

The specimen figured is from Kyska Harbor, Aleutian Islands. U. S. Nat. Mus. Cat. No. 160085. Collected by W. H. Dall.

METULA ELONGATA Dall

Plate 23, fig. 4

Metula elongata Dall, Smithsonian Misc. Coll., vol. 50, p. 166, 1907. Suruga Gulf, Japan, in 57 fathoms. U. S. Nat. Mus. Cat. No. 110502.

METZGERIA CALIFORNICA Dall

Plate 2, fig. 4

Metzgeria californica Dall, Nautilus, vol. 17, p. 52, 1903. Santa Barbara Channel, Calif. U. S. Nat. Mus. Cat. No. 172694.

MICROGAZA FULGENS Dall

Plate 36, figs. 2, 10

Microgaza fulgens Dall, Smithsonian Misc. Coll., vol. 50, p. 168, 1907. Sea of Japan, in 181 fathoms. U. S. Nat. Mus. Cat. No. 110543.

MITRA DOLOROSA Dall

Plate 21, fig. 6

Mitra dolorosa Dall, Proc. Biol. Soc. Wash., vol. 16, p. 173, Dec. 1903. Gulf of California. U. S. Nat. Mus. Cat. No. 109009.

MOHNIA BUCCINOIDES Dall

Plate 33, fig. 10

Mohnia buccinoides Dall, Proc. Acad. Nat. Sci. Phila. for 1913, p. 503.
Off Hondo, Japan, in 905 fathoms. U. S. Nat. Mus. Cat. No. 110778.

MOHNIA CLARKI Dall

Plate 30, fig. 2

Mohnia clarki Dall, Smithsonian Misc. Coll., vol. 50, p. 163, 1907.
Okhotsk Sea, in 682 fathoms. U. S. Nat. Mus. Cat. No. 110497.

MOHNIA JAPONICA Dall

Plate 32, fig. 6

Mohnia japonica Dall, Proc. Acad. Nat. Sci. Phila. for 1913, p. 503.
Off Sado Island, Japan, in 225 fathoms. U. S. Nat. Mus. Cat. No. 205244.

MOHNIA HONDOËNSIS Dall

Plate 32, fig. 4

Mohnia hondoënsis Dall, Proc. Acad. Nat. Sci. Phila. for 1913, p. 504.
Off Hondo, Japan, in 76 fathoms. U. S. Nat. Mus. Cat. No. 205253.

MOHNIA KURILANA Dall

Plate 34, fig. 1

Mohnia kurilana Dall, Proc. Acad. Nat. Sci. Phila. for 1913, p. 503.
Off the Kuril Islands, in 229 fathoms. U. S. Nat. Mus. Cat. No. 205224.

MOHNIA MICRA Dall

Plate 30, fig. 9

Mohnia micra Dall, Smithsonian Misc. Coll., vol. 50, p. 162, 1907.
Off Sado Island, Japan Sea, in 200 fathoms. U. S. Nat. Mus. Cat. No. 110499.

MOHNIA SORDIDA Dall

Plate 30, fig. 3

Mohnia sordida Dall, Smithsonian Misc. Coll., vol. 50, p. 162, 1907.
Sugaru Strait, Japan, in 300 fathoms. U. S. Nat. Mus. Cat. No. 110496.

MOHNIA VERNALIS Dall

Plate 2, fig. 2; plate 30, fig. 4

Mohnia vernalis Dall, Proc. Acad. Nat. Sci. Phila. for 1913, p. 502.
Off Tillamook Bay, Oreg. in 786 fathoms. U. S. Nat. Mus. Cat. No. 213334.

MUREX (PTEROPURPURA) ESYCHUS, new species

Plate 32, fig. 9, plate 33, fig. 6

Shell small, short, with three sharp varices, a smooth blunt nucleus of nearly two, and three rapidly enlarging subsequent whorls; suture distinct, not deep or appressed; axial sculpture of three broad,

sharp, thin varices, crenulate at the edge, guttered and produced at the shoulder; there is one small hump between the varices, but the rest of the axial sculpture is obscure; spiral sculpture of the ridge at the shoulder and eight minor ridges between the shoulder and the canal, chiefly noticeable on the varices; aperture subovate, with no tooth at the margin; canal closed, short, strongly recurved: height, 32; maximum diameter, 25 mm. U. S. Nat. Mus. Cat. No. 110773.

Dredged by the United States Bureau of Fisheries steamer *Albatross* in Kagoshima Gulf, Japan, in 103 fathoms, at station 4935.

This species belongs to the group of *M. speciosa* Adams and Reeve, and not to the group with toothed aperture like *M. burnetti.*

NEPTUNEA ALASKANA Dall

Plate 22, fig. 3

Boreotrophon alaskanus Dall, Proc. U. S. Nat. Mus., vol. 24, p. 545, 1902.

Bering Sea, north of Unalaska, in 225 fathoms. U. S. Nat. Mus. Cat. No. 122594.

NEPTUNEA GORGON Dall

Plate 23, fig. 1

Boreotrophon gorgon Dall, Proc. U. S. Nat. Mus., vol. 45, No. 2002, p. 588; June, 1913.

Dredged by the United States Bureau of Fisheries steamer *Albatross*, off Hondo, Japan, at station 3698, in 153 fathoms, mud, bottom temperature 65° F. The shell is 42 mm. in length and of a waxen white color. U. S. Nat. Mus. Cat. No. 110771.

NEPTUNEA (TROPHONOPSIS) MACLAINI Dall

Plate 21, fig. 11

Boreotrophon maclaini Dall, Proc. U. S. Nat. Mus., vol. 24, p. 538, 1902.

Baffin Bay, off Greenland. U. S. Nat. Mus. Cat. No. 126974.

This shell is immature.

NEPTUNEA PANAMENSIS Dall

Plate 21, fig. 4

Boreotrophon panamensis Dall, Proc. U. S. Nat. Mus., vol. 24, p. 546, 1902.

Off Panama Bay, in 1,270 fathoms. U. S. Nat. Mus. Cat. No. 123021.

NUCULA MIRIFICA Dall

Plate 29, figs. 4, 10

Nucula mirifica Dall, Smithsonian Misc. Coll., vol. 50, p. 170, 1907.

Off the south coast of Yesso, Japan, in 269 fathoms. U. S. Nat. Mus. Cat. No. 110463.

This is probably the largest smooth recent *Nucula* known, though the Japanese species of *Acila* reaches a still greater size.

OSTREA CRISTATA Born

Plate 28, figs. 7, 8

Ostrea cristata BORN, Mus. Caes., pl. 7, fig. 3, 1780.
Florida, on Gorgonians. U. S. Nat. Mus. Cat. No. 95934.

OSTREA EQUESTRIS Say

Plate 28, figs. 1, 3

Ostrea equestris SAY, Amer. Conch., vol. 6, pl. 58, 1834.
Florida. U. S. Nat. Mus. Cat. No. 95935.

OSTREA FRONS Linnaeus

Plate 28, fig. 5

Mytilus frons LINNAEUS, Syst. Nat., ed. 10, p. 704, 1758.
Florida. U. S. Nat. Mus. Cat. No. 207000.

OSTREA PERMOLLIS Sowerby

Plate 27, fig. 9, 10

Ostraea permollis SOWERBY, in Conch. Iconica, *Ostraea*, pl. 10, figs. 18*a*, 18*b*, Jan. 1871.
Florida. U. S. Nat. Mus. Cat. No. 173264.

PECTEN (LYROPECTEN) PITTIERI Dall

Plate 17, fig. 6

Pecten (*Lyropecten*) *pittieri* DALL, Smithsonian Misc. Coll., vol. 59, p. 10, 1912.
Later Tertiary of Moen Hill, near Limon, Costa Rica. U. S. Nat. Mus. Cat. No. 214368.

PHACOIDES (PARVILUCINA) TENUISCULPTA Carpenter

Plate 20, fig. 5

Lucina tenuisculpta CARPENTER, Suppl. Rep. Brit. Assoc., p. 642, 1864.
Puget Sound. U. S. Nat. Mus. Cat. No. 122581.

PHENACOPTYGMA CORTEZI Dall

Plate 1, fig. 7

Daphnella (*Surculina*) *cortezi* DALL, Bull. Mus. Comp. Zool., vol. 43, No. 6, p. 292, 1908.
Phenacoptygma cortezi DALL, Proc. Biol. Soc. Wash., vol. 31, p. 138, 1918; Proc. U. S. Nat. Mus., vol. 56, No.. 2295, p. 308, 1919.
Cortez Bank, off San Diego, Calif., in 984 fathoms. U. S. Nat Mus.. Cat. No. 204050.

PSAMMOBIA (GOBRAEUS) EDENTULA Gabb

Plate 19, fig. 1

Psammobia edentula GABB, Pal. Cal., vol. 2, p. 53, pl. 15, fig. 11, 1869.
San Pedro, Calif.; recent specimen. U. S. Nat. Mus. Cat. No. 107787.

PSEUDAMUSIUM ARCES Dall

Plate 27, fig. 4

Pseudamusium arces Dall, Proc. U. S. Nat. Mus., vol. 45, p. 593, 1913.
Off Santa Cruz Island, Calif., in 534 fathoms. U. S. Nat. Mus. Cat. No. 267169.

PUNCTURELLA CUCULLATA Gould

Plate 26, fig. 6, 8

Puncturella cucullata Gould, Proc. Boston Soc. Nat. Hist., vol. 2, p. 159, 1846.
Off the coast of Washington in 66 fathoms. U. S. Nat. Mus. Cat. No.. 106866.

PUPILLARIA ROSSICA Dall

Plate 25, fig. 1

Margarites (*Pupillaria*) *rossicus* Dall, Proc. U. S. Nat. Mus., vol. 56, p. 365, 1919.
Aniwa Bay, Sakhalin Island. U. S. Nat. Mus. Cat. No. 111046.

PUPILLARIA STRIATA Broderip and Sowerby

Plate 25, fig. 6

Margarita striata Broderip and Sowerby, Zool. Journ., vol. 4, p. 371, 1829.
Walter Thymen's fiord, Spitsbergen. U. S. Nat. Mus. Cat. No. 109460*a*.

PHOLADOMYA PACIFICA Dall

Plate 29, figs. 8, 9

Pholadomya pacifica Dall, Smithsonian Misc. Coll., vol. 50, p. 115, 1907; Nautilus, vol. 22, pp. 115, 142, 1909.
Off Hakodate, Japan, in 44 fathoms. U. S. Nat. Mus. Cat. No. 110545.

PLICATULA GIBBOSA Lamarck

Plate 27, figs. 6, 7

Plicatula gibbosa Lamarck, Syst. An. s. Vert., p. 132, 1801.
Plicatula ramosa Lamarck, Anim. s. Vert., vol. 6, p. 182, 1819.
Florida. U. S. Nat. Mus. Cat. No. 102895.

PLICIFUSUS ARCTICUS Philippi

Plate 22, fig. 4

Fusus arcticus Philippi, Abb. u. Beschr., vol. 3, p. 119, pl. 5, fig. 5, 1850.
Bering Sea. U. S. Nat. Mus. Cat. No. 122678.

PLICIFUSUS (HELICOFUSUS) AURANTIUS Dall

Plate 32, fig. 1

Tritonofusus (*Plicifusus*) *aurantius* Dall, Smithsonian Misc. Coll., vol. 50, p. 160, 1907.
Sea of Japan, in 390 fathoms. U. S. Nat. Mus. Cat. No. 110490.

PLICIFUSUS CROCEUS Dall

Plate 32, fig. 2

Tritonofusus (*Plicifusus*) *croceus* DALL, Smithsonian Misc. Coll., vol. 50, p. 161, 1907.

Sea of Japan, in 390 fathoms. U. S. Nat. Mus. Cat. No. 110491.

PLICIFUSUS (RETIFUSUS) INCISUS Dall

Plate 1, fig. 5

Plicifusus (*Retifusus*) *incisus* DALL, Proc. U. S. Nat. Mus., vol. 56, p. 314, 1919.

Western Bering Sea, in 100 fathoms. U. S. Nat. Mus. Cat. No. 224118.

PLICIFUSUS LATICORDATUS Dall

Plate 1, fig. 4

Tritonofusus aurantius, var. *laticordatus* DALL, Smithsonian Misc. Coll., vol. 50, p. 161, 1907.

Bristol Bay, Alaska, in 41 fathoms. U. S. Nat. Mus. Cat. No. 210801.

PLICIFUSUS (RETIFUSUS) OCEANODROMAE Dall

Plate 3, fig. 3

Plicifusus (*Retifusus*) *oceanodromae* DALL, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 314, 1919.

Petrel Bank, Bering Sea, in 52 fathoms. U. S. Nat. Mus. Cat. No. 205924.

PLICIFUSUS POLYPLEURATUS Dall

Plate 34, fig. 7

Tritonofusus (*Plicifusus*) *polypleuratus* DALL, Smithsonian Misc. Coll., vol. 50, p. 159, 1907.

Japan Sea in 88 fathoms. U. S. Nat. Mus. Cat. No. 110476.

PLICIFUSUS RHYSSUS Dall

Plate 33, fig. 7

Tritonofusus (*Plicifusus*) *rhyssus* DALL, Smithsonian Misc. Coll., vol. 50, p. 160, 1907.

Aniwa Bay, Sakhalin, in 43 fathoms. U. S. Nat. Mus. Cat. No. 110489.

PYRULOFUSUS HARPA Mörch

Plate 24, fig. 1

Neptunea harpa MÖRCH, Novit. Conch. Moll. Marina, p. 5, pl. 1, figs. 3, 4, 1858

Shumagin Islands. U. S. Nat. Mus. Cat. No. 221750.

RECLUZIA PALMERI Dall

Plate 17, fig. 8

Lymnaea (?) *palmeri* DALL, Amer. Journ. Conch., vol. 7, p. 135, 1871.

Delta of the Yaqui River, Gulf of California. U. S. Nat. Mus. Cat. No. 56411.

This should be compared with *R. rollandiana* Petit, 1853.

SANGUINOLARIA (NUTTALLIA) ORCUTTI Dall

Plate 12, figs. 1, 2

Sanguinolaria (Nuttallia) orcutti Dall, West Amer. Scientist, vol. 19, No. 2, p. 17, 1921.

Pliocene (?) of San Quentin Bay, Lower California. U. S. Nat. Mus. Cat. No. 333118.

SEMELE QUENTINENSIS Dall

Plate 8, fig. 4

Semele quentinensis Dall, West Amer. Scientist, vol. 19, No. 3, p. 22, 1921.

Pliocene (?) of San Quentin Bay, Lower California. U. S. Nat. Mus. Cat. No. 333114.

SEMELE RUBROPICTA Dall

Plate 18, figs. 1, 2

Semele rubropicta Dall, Amer. Journ. Conch., vol. 7, p. 144, pl. 14, fig. 10, 1871.

Beach at Soquel, Monterey Bay, Calif. U. S. Nat. Mus. Cat. No. 101960.

SERRIPES LAPEROUSII Deshayes

Plate 20, fig. 3

Cardium laperousii Deshayes, Rev. Zool. Soc. Cuv., 1839, p. 360; Mag. de Zool., 1841, pl. 48.

Unalaska, Alaska. U. S. Nat. Mus. Cat. No. 221603.

SILIQUA PATULA Dixon

Plate 19, fig. 3

Solen patulus Dixon, Voyage, p. 355, fig. 2, 1788.

Bering Island, Bering Sea. U. S. Nat. Mus. Cat. No. 106876.

SIPHONARIA (LIRIOLA) THERSITES Carpenter

Plate 33, figs. 2, 3

Siphonaria thersites Carpenter, Ann. Mag. Nat. Hist., ser. 3, vol. 14, p. 425, 1864.

Southeastern Alaska. U. S. Nat. Mus. Cat. No. 55802.

SOLARIELLA ELEGANTULA Dall

Plate 23, figs. 5, 9

A single specimen was dredged by the U. S. Bureau of Fisheries steamer *Albatross* in the Gulf of California, off La Paz, in 26½ fathoms. The height of the specimen is 5.5 mm. U. S. Nat. Mus. Cat. No. 111384.

SPISULA CAMERONIS Dall

Plate 10, fig. 2, plate 11, fig. 4

Spisula cameronis Dall, West Amer. Scientist, vol. 19, No. 3, p. 22, 1921.

Pliocene (?) of San Quentin Bay, Lower California. U. S. Nat. Mus. Cat. No. 333117.

SPISULA LONGA Dall

Plate 10, fig. 1, plate 11, fig. 3

Spisula longa DALL, West Amer. Scientist, vol. 19, No. 3, p. 22, 1921.
Pliocene (?) of San Quentin Bay, Lower California. U. S. Nat. Mus. Cat. No. 333116.

STHENORYTIS TOROËNSE Dall

Plate 18, fig. 5

Epitonium (*Sthenorytis*) *toroënse* DALL, Smithsonian Misc. Coll., vol. 59, p. 6, 1912.
Pliocene of Toro Point, Canal Zone, Panama. U. S. Nat. Mus. Cat. No. 214340.

STROMBINA LILACINA Dall

Plate 35, fig. 5

Strombina lilacina DALL, Nautilus, vol. 30, p. 28, 1916.
Gulf of California. U. S. Nat. Mus. Cat. No. 219764.

SUAVODRILLIA SAGAMIANA, new species

Plate 21, fig. 2

Shell large, solid, biconic, grayish white, with 8 whorls exclusive of the (lost) nucleus; suture closely appressed, the anal fasciole in front of it incrementally striated and slightly constricted; spiral sculpture of a strong axially wrinkled cord forming the anterior boundary of the fasciole, and in front of the cord numerous inconspicuous threads with equal or narrower interspaces extending to the end of the canal; axial sculpture only of incremental lines, emphasized on the ridges at the suture and shoulder; aperture ample, anal sulcus wide, outer lip sharp and arcuately produced, body erased, throat smooth, pillar attenuated, canal short and wide; height of shell, 37; of last whorl, 25; diameter, 15 mm. U. S. Nat. Mus. Cat. No. 110780.

Dredged by the United States Bureau of Fisheries steamer *Albatross* at station 5088, in 369 fathoms, mud, off Hondo in Sagami Bay, bottom temperature 41.8° F.

This is larger and stouter than *S. kennicottii* Dall, of Alaska, but of the same general type.

TEREBRA CONCAVA Say

Plate 9, fig. 8

Turritella concava SAY, Journ. Acad. Nat. Sci. Phila., vol. 5, p. 207, Feb. 1826.
Charleston, S. C. U. S. Nat. Mus. Cat. No. 87155.

TEREBRATALIA LATA Dall

Plate 13, figs. 1, 2

Terebratalia lata DALL, West Amer. Scientist, vol. 19, p. 18, 1921.
Pliocene (?) of San Quentin Bay, Lower California. U. S. Nat. Mus. Cat. No 333150.

THRACIA QUENTINENSIS Dall

Plate 11, fig. 1

Thracia quentinensis Dall, West Amer. Scientist, vol. 19, No. 3, p. 21, 1921.
Pliocene (?) of San Quentin Bay, Lower California. U. S. Nat. Mus. Cat. No. 333112.

TRICHODISCINA VERDENSIS Dall

Plate 23, figs. 7, 10, 12

Epiphragmophora (Trichodiscina) verdensis Dall, Nautilus, vol. 24, p. 35, July, 1910.
Oaxaca, Mexico. U. S. Nat. Mus. Cat. No. 212318.

TRITONALIA CIRCUMTEXTA Stearns

Plate 25, fig. 4

Ocinebra circumtexta Stearns, Conch. Memo., No. 6, p. 1, 1871.
Santa Rosa Island, Calif. U. S. Nat. Mus. Cat. No. 59385.

TROMINA UNICARINATA Philippi

Plate 21, fig. 7

Fusus unicarinatus Phillippi, Malak. Blätt., vol. 15, p. 223, 1868.
Trophon unicarinatus Tryon, Man. Conch., vol. 2, p. 151, 1880.
Tromina unicarinata Dall, Proc. U. S. Nat. Mus. vol. 24, p. 536, 1902.
Magellan Straits, in 20 fathoms. U. S. Nat. Mus. Cat. No. 96193.

TROPHON PINNATUS Dall

Plate 22, fig. 5

Trophon pinnatus Dall, Proc. U. S. Nat. Mus. vol. 24, p. 549, 1902.
Magdalena Bay, Lower California, in 21 to 74 fathoms. U. S. Nat. Mus. Cat. No. 124689.

TURBO ASTERIOLA, new species

Plate 36, figs. 1, 7

Shell small, pinkish above, creamy white below, with a minute depressed nucleus of 3 and 3 subsequent whorls; suture distinct, not appressed; spiral sculpture of, on the early whorls, 1; on the next whorl, 2; and on the last whorl, 3 rows of small nodules, the largest near the suture; these are followed at the periphery by a series of (on the last whorl 12) slender spines, and on the edge of the base by a low nodulous keel; there is a minute row of pustules just behind the pillar; there is practically no axial sculpture except faint lines of growth; the base is flattish, the aperture rounded but slightly angulated by the sculpture; the pillar is short, simple; the operculum externally granular; height of shell, 14; diameter, including spines, 20 mm. U. S. Nat. Mus. Cat. No. 205733.

Dredged in Colnett Strait, Eastern Sea of Japan, at station 4924, by the United States Bureau of Fisheries steamer *Albatross*, in 159 fathoms, rocky bottom, temperature 58.8° F. Caught on the tangles.

This little species is very distinct and extremely elegant.

TURCICULA JAPONICA, new species

Plate 36, fig. 11

Shell small for the genus; as only dead specimens were obtained the original color is uncertain; they are now grayish white; apex acute, the nucleus eroded, but there are about 6 subsequent whorls; suture distinct, minutely crenulated; axial sculpture of minutely imbricate sharp incremental lines over the whole surface; above the periphery there are 3 spiral rows of subspinose nodules; on the base behind the pillar are 4 spiral rows of minute nodules and 2 minor threads immediately behind the pillar; aperture subcircular, pearly; lips simple, pillar convexly arcuate, smooth; base impervious; height of shell, 28; diameter, 17 mm. U. S. Nat. Mus. Cat. No. 205752.

Dredged by the United States Bureau of Fisheries steamer *Albatross*, at station 5093, in Uraga Strait, off Hondo, Japan, in 302 fathoms, sand, bottom temperature 43.9° F. Other specimens were obtained at station 5088, off Hondo, in 369 fathoms, mud, temperature 41.8° F.

The largest of the latter lot, though broken, was 30 mm. high. This species is much like the typical form from the West Indies.

TURRICULA (SURCULA) HONDOANA, new species

Plate 31, fig. 6

Shell acute, biconic, of a dull grayish white with a polished periostracum, and seven angular whorls exclusive of the (lost) nucleus; suture inconspicuous, closely appressed; axial sculpture only of incremental lines; spiral sculpture of a strong cord at the anterior edge of the anal fasciole which angulates the whorl, in the middle of the fasciole is an obscure ridge; in front of the shoulder the whorl is sharply sculptured with narrow channelled grooves, with wider flattish interspaces, except on the canal where they are replaced by finer close striation; aperture narrow, anal sulcus wide and deep, outer lip thin, strongly produced arcuately; body with a thin wash of enamel; pillar straight, attenuated in front, canal narrow; height of shell, 58; of last whorl, 39; maximum diameter, 21 mm. U. S. Nat. Mus. Cat. No. 111052.

Dredged by the United States Bureau of Fisheries steamer *Albatross* at station 5087, off Hondo, Sagami Bay, Japan, in 614 fathoms, mud, bottom temperature 37.5° F.

This has much the aspect of *Aforia circinata* Dall, from the Bering Sea, but shows no indication of the anterior furrow in the outer lip.

TURRIS? SIMPLICISSIMA Dall

Plate 35, fig. 7

Pleurotomella simplicissima Dall, Smithsonian Misc. Coll., vol. 50, p. 140, 1907.

Okhotsk Sea, 1,800 fathoms. U. S. Nat. Mus. Cat. No. 110542.

UROSALPINX PERRUGATUS Conrad

Plate 26, fig. 7

Fusus perrugatus Conrad, Amer. Journ. Sci., n. ser. vol. 2, p. 397, 1846.

Cedar Keys, Florida. U. S. Nat. Mus. Cat. No. 36151.

VESICOMYA SUAVIS Dall

Plate 27, fig. 1

Vesicomya suavis Dall, Proc. U. S. Nat. Mus., vol. 45, p. 597, 1913.

West coast of Lower California, off Animas, in 735 fathoms. U. S. Nat. Mus. Cat. No. 266881.

VOLUTA ALFAROI Dall

Plate 17, fig. 2

Voluta alfaroi Dall, Smithsonian Misc. Coll., vol. 59, No. 2, p. 8, 1912.

Later Tertiary of Costa Rica. U. S. Nat. Mus. Cat. No. 214347.

VOLUTHARPA AMPULLACEA ACUMINATA Dall

Plate 35, fig. 3

Volutharpa ampullacea Middendorff, var. *acuminata* Dall, Amer. Journ. Conch., vol. 7, p. 104, 1871.

Sitka, Alaska, in shallow water. U. S. Nat. Mus. Cat. No. 87862.

VOLUTOPSIUS HIRASEI Pilsbry

Plate 31, fig. 3

Volutopsius hirasei Pilsbry, Proc. Acad. Nat. Sci. Phila. for 1907, p. 243, pl. 19, fig. 2.

Off Cape Clonard, Japan Sea. U. S. Nat. Mus. Cat. No. 110776.

VOLUTOPSIUS MINOR, new species

Plate 32, fig. 3

Shell small for the genus, slender, acute, pale chestnut brown with a smooth periostracum, and five and a half whorls exclusive of the nucleus which is blunt and includes a whorl and a half; suture well defined, not appressed, whorls moderately rounded; axial sculpture only of faint incremental lines; spiral sculpture of obscure striae, about three to a millimeter, with wider flattish interspaces over the whole

surface; aperture narrow, outer lip thin, sharp; body erased; pillar slightly concavely arcuate, attenuated in front, the axis pervious; canal hardly differentiated from the aperture; height of shell, 41; of last whorl, 27; diameter, 14 mm. U. S. Nat. Mus. Cat. No. 110779.

Dredged in Aniwa Bay, Sakhalin Island, by the United States Bureau of Fisheries steamer *Albatross*, at station 5009, in 25 fathoms, mud, bottom temperature 38.5° F.

The operculum has a slightly coiled nucleus approaching that of *Mohnia*, but the habit of the shell is that of the elongate *Volutopsius*.

VOLUTOPSIUS ROTUNDUS Dall

Plate 6, fig. 4

Volutopsius rotundus Dall, Proc. U. S. Nat. Mus., vol. 56, No. 2295, p. 310, 1919.

Kodiak Island, Alaska. U. S. Nat. Mus. Cat. No. 206350.

VOLVULA ASPINOSA Dall

Plate 25, fig. 5

Volvula aspinosa Dall, Bull. Mus. Comp. Zool., vol. 18, p. 51, 1889.

Off Cape Hatteras, N. C. U. S. Nat. Mus. Cat. No. 95302.

VOLVULA BUSHII Dall

Plate 25, fig. 3

Volvula bushii Dall, Bull. Mus. Comp. Zool., vol. 18, p. 51, 1889.

Off Cape Hatteras, N. C. U. S. Nat. Mus. Cat. No. 95301.

WILLIAMIA VERNALIS Dall

Plate 27, figs. 3, 5

Siphonaria vernalis Dall, Amer. Journ. Conch., vol. 6, p. 38, 1870.

Monterey, Calif., on kelp. U. S. Nat. Mus. Cat. No. 32596.

YOLDIA (CNESTERIUM) EXCAVATA, new species

Plate 19, fig. 2

Shell rather large, olivaceous in darker and lighter concentric zones, with a brilliant periostracum; inequilateral, equivalve, somewhat attenuated posteriorly and slightly rostrate; surface except on the dorsal aspect of the rostrum, deeply and sharply sculptured with oblique groovings; beaks inconspicuous, the lunule compressed and vertically produced; the anterior slope gently curved, the anterior end rounded, the base evenly arcuate, the posterior dorsal slope slightly concave, the posterior end pointed and slightly recurved; posterior hinge teeth about 15, anterior series about 27; the resilifer large, the pallial sinus large and rounded; total length, 40; beaks in front of the posterior end, 17; altitude at the beaks 20; diameter, 8 mm. U. S. Nat. Mus. Cat. No. 249337.

Otaru, Japan; University of Tokio. Collected by Prof. E. S. Morse.

This species compared with *Y. johanni* is more equilateral, more completely and much more strongly obliquely sculptured and, when full grown, larger.

YOLDIA (CNESTERIUM) JOHANNI, new species

Plate 29, fig. 7

Shell olivaceous, compressed, inequilateral, equivalve, polished, smooth except for incremental lines and fine oblique rather widely spaced striae which occupy the middle part of the disk, stopping abruptly at about the anterior third and leaving a smaller space near the posterior end also vacant; the beaks are inconspicuous, the lunular area is compressed and vertically produced, the anterior slope nearly straight, the posterior end slightly rostrate and recurved, the basal margin evenly arcuate; there are about 16 posterior and 32 anterior hinge teeth, the ligament rather large and strong, the pallial line with a large rounded free sinus; total length, 30; the beaks in front of the posterior end, 12; altitude at the beaks, 13.5; diameter, 5 mm. U. S. Nat. Mus. Cat. No. 107694.

North Japan, in 7 fathoms, Captain St. John, R. N.

This belongs to the same group as *Y. seminuda* Dall, of the N. W. American coast, and can be distinguished from its nearest relative by the bare anterior portion. The artist, deceived by the brilliant surface, has carried the oblique grooves too far forward in the figure.

YOLDIA PERPROTRACTA Dall

Plate 18, fig. 3

Yoldia perprotracta Dall, Smithsonian Misc. Coll., vol. 59, p. 1, 1912.

Later Tertiary of the Canal Zone, Panama. U. S. Nat. Mus. Cat. No. 214350.

INDEX TO GENERA

	Page
Acila	2
Acmaea	2
Agathotoma	2
Aligena	2
Amphissa	2
Anatina	2
Ancistrolepis	3
Anisospira	17
Anomalosipho	11
Antiplanes	4
Arca	5
Astraea	5
Aulacofusus	12
Basilissa	5
Beringius	5
Bolma	6
Boreoscala	6
Boreotrophon	22
Borsonella	6
Buccinum	6
Cadulus	9
Calliostoma	9
Chrysodomus	9
Cirsotrema	10
Cnesterium	30
Cocculina	11
Colus	11
Coralliophila	14
Corbicula	15
Corbula	15
Cosmioconcha	2
Crenella	15
Cryptomya	15
Cumingia	15
Cuspidaria	15
Cyanocyclas	15
Cymatium	16
Cyrenodonax	15
Dentalium	16
Emarginula	16
Epiphragmophora	28
Epitonium	27
Erycina	16
Eucalodium	17
Eulima	20
Euspira	17
Exilia	17
Fusinus	17
Galeodea	17
Gobraeus	23
Gyrinopsis	18
Helicofusus	24
Ischnochiton	18
Lacuna	18
Latisipho	11, 12
Lima	18
Limatofusus	13, 14
Liocyma	18
Liomesus	18
Liotia	19
Liriola	26
Littorina	19
Lyonsia	19
Lyropecten	23
Macoma	19
Mactra	19
Mactrotoma	19
Margarites	19
Marginella	20
Melanella	20
Metula	20
Metzgeria	20
Microgaza	20
Mitra	20
Mohnia	21
Murex	21
Neptunea	22
Nucula	22
Nuttallia	26
Orectospira	5
Ostrea	23
Parvilucina	23
Pecten	23
Phacoides	23
Phenacoptygma	23
Pholadomya	24
Plicatula	24
Plicifusus	24
Psammobia	23
Pseudamusium	24
Pteropurpura	21
Puncturella	24
Pupillaria	24
Pyrulofusus	25
Raetina	2
Recluzia	25
Retifusus	25
Sanguinolaria	26
Semele	26
Serripes	26

	Page
Siliqua	26
Siphonaria	26
Solariella	26
Spisula	26
Sthenorytis	27
Strombina	27
Suavodrillia	27
Surculina	28
Terebra	27
Terebratalia	27
Thracia	28
Trichodiscina	28
Tritonalia	28
Tromina	28
Trophon	22
Turbo	28
Turcicula	29
Turricula	29
Turris	30
Urosalpinx	30
Valvatella	19
Vesicomya	30
Voluta	30
Volutharpa	30
Volutopsius	30
Volvula	31
Williamia	31
Yoldia	31

EXPLANATION OF PLATES

PLATE 1

Fig.		Page
1.	*Colus* (*Limatofusus*) *morditus* Dall, alt. 28 mm	13
2.	*Colus* (*Limatofusus*) *timetus* Dall, alt. 30 mm	14
3.	*Colus* (*Latisipho*) *aphelus* Dall, alt. 30 mm	11
4.	*Placifusus laticordatus* Dall, alt. 20 mm	25
5.	*Plicifusus* (*Retifusus*) *incisus* Dall, alt. 28 mm	25
6.	*Exilia kelseyi*, Dall, alt. 34 mm	17
7.	*Phenacoptygma cortezi* Dall, alt. 43 mm	23
8.	*Colus* (*Anomalosipho*) *adonis* Dall, alt. 37 mm	11
9.	*Colus* (*Latisipho*) *dalmasius* Dall, alt. 35 mm	12
10.	*Colus* (*Aulacofusus*) *trophius* Dall, alt. 32 mm	14
11.	*Colus* (*Aulacofusus*) *severinus* Dall, alt. 33 mm	14
12.	*Colus* (*Aulacofusus*) *halidonus* Dall, alt. 35 mm	13

PLATE 2

Fig.		Page
1.	*Fusinus diminutus* Dall, alt. 11 mm	17
2.	*Mohnia vernalis* Dall, alt. 21 mm.	21
3.	*Colus* (*Aulacofusus*) *dimidiatus* Dall, alt. 16 mm	12
4.	*Metzgeria californica* Dall, alt. 14 mm	20
5.	*Colus* (*Aulacofusus*) *barbarinus* Dall, alt. 20 mm	12
6.	*Colus* (*Aulacofusus*) *trombinus* Dall, alt. 16 mm	14
7.	*Colus* (*Aulacofusus*) *halimeris* Dall, alt. 21 mm. (immature ?)	13
8.	*Colus* (*Aulacofusus*) *bristolensis* Dall, alt. 23.5 mm	12
9.	*Colus* (*Latisipho*) *clementinus* Dall, alt. 21 mm	12
10.	*Colus* (*Aulacofusus*) *sapius* Dall, alt. 22 mm	14

PLATE 3

Fig.		Page
1.	*Colus* (*Aulacofusus*) *pulcius* Dall, alt. 38 mm	13
2.	*Colus* (*Aulacofusus*) *capponius* Dall, alt. 40 mm	12
3.	*Plicifusus* (*Retifusus*) *oceanodromae* Dall, alt. 34 mm	25
4.	*Fusinus traski Dall*, alt. 55 mm	17
5.	*Colus* (*Aulacofusus*) *ombronius* Dall, alt. 50 mm	13
6.	*Colus* (*Latisipho*) *errones* Dall, alt. 47 mm	12
7.	*Buccinum castaneum incisulum* Dall, alt. 55 mm	7
8.	*Buccinum tenue lyperum* Dall, alt. 52 mm	9
9.	*Ancistrolepis californicus* Dall, alt. 46 mm	3

PLATE 4

Fig.		Page
1.	*Buccinum solenum* Dall, alt. 47 mm	8
2.	*Chrysodomus smirnius* Dall, alt. 50 mm	10
3.	*Chrysodomus nuceus* Dall, alt. 62 mm	10
4.	*Buccinum cnismatopleura* Dall, alt. 48 mm	7
5.	*Buccinum physematum* Dall, alt. 60 mm	8
6.	*Chrysodomus saturus tabularis* Dall, alt. 62 mm	10

PLATE 5

Fig.		Page
1.	*Buccinum planeticum* Dall, alt. 65 mm	8
2.	*Buccinum pemphigus* Dall, alt. 63 mm	8
3.	*Buccinum castaneum fluctuatum* Dall, alt. 85 mm	7
4.	*Colus* (*Aulacofusus*) *nobilis* Dall, alt. 85 mm	13

Plate 6

		Page
Fig.	1. *Buccinum tenue rhodium* Dall, alt. 89 mm	9
	2. *Buccinum chartium* Dall, alt. 60 mm	7
	3. *Chrysodomus vinosus* Dall, alt. 90 mm	10
	4. *Volutopsius rotundus* Dall, alt. 105 mm	31
	5. *Beringius malleatus* Dall, alt. 85 mm	5

Plate 7

Fig.	1. *Ancistrolepis beringianus* Dall, alt. 98 mm	3
	2. *Beringius stimpsoni* Gould, alt. 100 mm	6
	3. *Beringius indentatus* Dall, alt. 110 mm	5
	4. *Chrysodomus pribiloffensis* Dall, alt. 94 mm	10

Plate 8

Fig.	1. *Agathotoma quentinensis* Dall, alt. 11 mm	2
	2, 3. *Macoma acolasta* Dall, lon. 22 mm	19
	4. *Semele quentinensis* Dall, lon. 24 mm	26
	5. *Cumingia densilineata* Dall, lon. 29 mm	15

Plate 9

Fig.	1. *Crenella columbiana* Dall, young shell, alt. 3.5 mm	15
	2. *Euspira bahamensis* Dall, diam. 7 mm	17
	3. *Cadulus californicus* Pilsbry and Sharp, lon. 20 mm	9
	4. *Melanella micans borealis* Bartsch, alt. 12.5 mm	20
	5. *Acila castrensis* Hinds, lon. 18 mm	2
	6. *Calliostoma tricolor*, Gabb alt. 19 mm	9
	7. *Melanella randolphi* Vanatta, alt. 7 mm	20
	8. *Terebra concava* Say, alt. 20 mm	27

Plate 10

Fig.	1. *Spisula longa* Dall, lon. 62 mm	27
	2. *Spisula cameronis* Dall, lon. 80 mm	26

Plate 11

Fig.	1. *Thracia quentinensis* Dall, lon. 47 mm	28
	2. *Cumingia densilineata* Dall, lon. 29 mm	15
	3. *Spisula longa* Dall, lon. 62 mm	27
	4. *Spisula cameronis* Dall, lon. 80 mm	26

Plate 12

Fig.	1–2. *Sanguinolaria (Nuttallia) orcutti* Dall, lon. 130 mm	26

Plate 13

Fig.	1. *Terebratalia lata* Dall, brachial valve, lat. 61 mm	27
	2. *Terebratalia lata* Dall, pedicel valve, lat. 61 mm	27
	3. *Cryptomya magna* Dall, exterior of right valve, lon. 35 mm	15
	4. *Cryptomya magna* Dall, interior of left valve, lon. 35 mm	15

Plate 14

Fig.	1. *Chrysodomus eulimatus* Dall, adult shell, natural size	9

PLATE 15

Page

FIG. 1. *Acmaea digitalis* Eschscholtz, series showing variations, natural size, F. W. Kelsey photo ---- 2

PLATE 16

FIG. 1. *Acmaea digitalis* Eschscholtz, series continued, natural size, F. W. Kelsey photo ---- 2

PLATE 17

FIG. 1. *Corbula macdonaldi* Dall, lon. 23 mm ---- 15
2. *Voluta alfaroi* Dall, alt. 51 mm ---- 30
3. *Corbula macdonaldi* Dall, lon. 23 mm ---- 15
4. *Marginella macdonaldi* Dall, alt. 28 mm ---- 20
5. *Marginella macdonaldi* Dall, alt. 28 mm ---- 20
6. *Pecten* (*Lyropecten*) *pittieri* Dall, alt. 132 mm ---- 23
7. *Arca* (*Scapharca*) *pittieri* Dall, alt. 25 mm ---- 5
8. *Recluzia palmeri* Dall, alt. 22.5 mm ---- 25
9. *Arca* (*Noetia*) *macdonaldi* Dall, lon. 45 mm ---- 5

PLATE 18

FIG. 1. *Semele rubropicta* Dall, interior right valve, lon. 28 mm ---- 26
2. *Semele rubropicta* Dall, exterior of right valve, lon. 28 mm ---- 26
3. *Yoldia perprotracta* Dall, lon. 29 mm ---- 32
4. *Gyrinopsis cowlitzi* Dall, alt. 65 mm ---- 18
5. *Sthenorytis toroense* Dall, alt. 30 mm ---- 27
6. *Gyrinopsis cowlitzi* Dall, alt. 65 mm ---- 18
7. *Ischnochiton* (*Stenoplax*) *conspicua* Carpenter, abnormal six-valved specimen, natural size ---- 18

PLATE 19

FIG. 1. *Psammobia* (*Gobraeus*) *edentula* Gabb, recent specimen, lon. 124 mm ---- 23
2. *Yoldia* (*Cnesterium*) *excavata* Dall, lon. 30 mm ---- 31
3. *Siliqua patula* Dixon, lon. 130 mm ---- 26

PLATE 20

FIG. 1. *Mactra* (*Mactrotoma*) *californica* Conrad, lon. 26 mm ---- 19
2. *Anatina* (*Raetina*) *indica* Dall, lon. 43 mm ---- 2
3. *Serripes laperousii* Deshayes, lon. 110 mm ---- 26
4. *Cuspidaria glacialis* Sars, lon. 37 mm ---- 15
5. *Phacoides* (*Parvilucina*) *tenuisculpta* Carpenter, lon. 12.5 mm ---- 23

PLATE 21

FIG. 1. *Amphissa* (*Cosmioconcha*) *parvula* Dall, alt. 15.25 mm ---- 2
2. *Suavodrillia sagamiana* Dall, alt. 36 mm ---- 27
3. *Antiplanes yessoensis* Dall, alt. 36 mm ---- 4
4. *Neptunea panamensis* Dall, alt. 22 mm ---- 22
5. *Antiplanes piona* Dall, alt. 40 mm ---- 4
6. *Mitra dolorosa* Dall, alt. 19 mm ---- 20
7. *Tromina unicarinata* Philippi, alt. 8 mm ---- 28

Page

FIG. 8. *Amphissa (Cosmioconcha) palmeri* Dall, alt. 18 mm — 2
9. *Amphissa (Cosmioconcha) pergracilis* Dall, alt. 24 mm — 2
10. *Borsonella callicesta* Dall, alt. 19.3 mm — 6
11. *Neptunea (Trophonopsis) maclaini* Dall, alt. 6.5 mm (immature) — 22
12. *Cirsotrema plexis* Dall, alt. 45.5 mm — 10
12*a*. Enlargement of surface of varix to show the character of the minor sculpture of *Cirsotrema plexis*.

PLATE 22

FIG. 1. *Antiplanes thalaea* Dall, alt. 40 mm — 4
2. *Boreoscala greenlandica* Perry, alt. 52 mm — 6
3. *Neptunea alaskana* Dall, alt. 32 mm — 22
4. *Plicifusus arcticus* Philippi, alt. 103 mm — 24
5. *Trophon pinnatus* Dall, alt. 70 mm — 28

PLATE 23

FIG. 1. *Neptunea gorgon* Dall, alt. 39 mm — 22
2. *Lyonsia magnifica* Dall, lon. 25 mm — 19
3. *Margarites albolineatus* E. A. Smith, base of shell, lat. 11 mm — 19
4. *Metula elongata* Dall, alt. 35.5 mm — 20
5. *Solariella elegantula* Dall, base, diam. 5.5 mm — 26
6. *Margarites albolineatus* E. A. Smith, profile, lat. 11 mm — 19
7. *Trichodiscina verdensis* Dall, profile, lat. 18.5 mm — 28
8. *Eucalodium (Anisospira) orcutti* Dall, alt. 39 mm., including apical whorls — 17
9. *Solariella elegantula* Dall, alt. 5.5 mm — 26
10. *Trichodiscina verdensis* Dall, base, lat. 18.5 mm — 28
11. Section showing internal structure of *Eucalodium orcutti* — 17
12. *Trichodiscina verdensis* Dall, upper surface, diam. 18.5 mm — 28

PLATE 24

FIG. 1. *Pyrulofusus harpa* Mörch, natural size — 25
2. *Calliostoma nepheloide* Dall, profile, alt. 25.5 mm — 9
3. *Calliostoma nepheloide* Dall, base, diam. 22 mm — 9

PLATE 25

FIG. 1. *Pupillaria rossica* Dall, alt. 30 mm — 24
2. *Littorina grönlandica* Menke, alt. 11 mm — 19
3. *Volvula bushi* Dall, lon. 4.6 mm — 31
4. *Tritonalia circumtexta* Stearns, alt. 22 mm — 28
5. *Volvula aspinosa* Dall, lon. 4 mm — 31
6. *Pupillaria striata* Broderip and Sowerby, alt. 19 mm — 24
7. *Littorina sitkana* Philippi, alt. 16 mm — 19

PLATE 26

FIG. 1. *Emarginula choristes* Dall, basal lon. 17 mm — 16
2. *Colus (Aulacofusus) roseus* Dall, alt. 22 mm — 13
3. *Cocculina japonica* Dall, lon. 8.2 mm — 11
4. *Emarginula choristes* Dall, alt. 18 mm — 16

	Page
Fig. 5. *Cocculina japonica* Dall, lon. 8.2 mm	11
6. *Puncturella cucullata* Gould, profile, alt. 22.5 mm	24
7. *Urosalpinx perrugatus* Conrad, alt. 27 mm	30
8. *Puncturella cucullata* Gould, interior view, lon. 22.5 mm	24
9. *Colus* (*Aulacofusus*) *sapius* Dall, alt. 23 mm	14

PLATE 27

Fig. 1. *Vesicomya suavis* Dall, lon. 35 mm	30
2. *Erycina colpoica* Dall, lon. 10 mm	16
3. *Williamia vernalis* Dall, lon. 14 mm	31
4. *Pseudamusium arces* Dall, alt. 21 mm	24
5. *Williamia vernalis* Dall, profile, lon. 14 mm	31
6. *Plicatula gibbosa* Lamarck, interior of right valve, lon. 28 mm	24
7. *Plicatula gibbosa* Lamarck, interior of left valve, lon. 28 mm	24
8. *Dentalium crocinum* Dall, lon. 39 mm	16
9. *Ostrea permollis* Sowerby, upper valve in place, lat. 40 mm	23
10. *Ostrea permollis* Sowerby, interior of lower valve, lat. 40 mm	23

PLATE 28

Fig. 1. *Ostrea equestris* Say, interior of lower valve, lon. 35 mm	23
2. *Aligena nucea* Dall, lon. 4.5 mm	2
3. *Ostrea equestris* Say, upper valve in place, lon. 35 mm	23
4. *Liocyma aniwana* Dall, young dorsal view, lon. 25 mm	18
5. *Ostrea frons* Linnaeus, inside of lower valve, natural size	23
6. *Liocyma aniwana* Dall, young profile, lon. 25 mm	18
7. *Ostrea cristata* Born, upper valve in place, lon. 45 mm	23
8. *Ostrea cristata* Born, interior of lower valve, lon. 45 mm	23

PLATE 29

Fig. 1. *Liocyma aniwana* Dall, adult profile, lon. 24 mm	18
2. *Liocyma aniwana* Dall, adult dorsal view, lon. 24 mm	18
3. *Corbicula* (*Cyrenodonax*) *formosana* Dall, lon. 12 mm	15
4. *Nucula mirifica* Dall, profile, lon. 36 mm	22
5. *Cuspidaria trosaetes* Dall, lon. 24 mm	16
6. *Lima hamlini* Dall, lon. 53 mm	18
7. *Yoldia johanni* Dall, lon. 28 mm	32
8. *Pholadomya pacifica* Dall, exterior of left valve, lon. 43.5 mm	24
9. The same, interior of left valve, lon. 43.5 mm	24
10. *Nucula mirifica* Dall, interior of left valve, lon. 36 mm	22

PLATE 30

Fig. 1. *Ancistrolepis okhotensis* Dall, alt. 45 mm	4
2. *Mohnia clarki* Dall, alt. 21 mm	21
3. *Mohnia sordida* Dall, alt. 26 mm	21
4. *Mohnia vernalis* Dall, alt. 21 mm	21
5. *Buccinum sakhalinensis* Dall, alt. 36 mm	8
6. *Buccinum aniwanum* Dall, alt. 48 mm	6
7. *Buccinum bombycinum* Dall, alt. 27 mm	6
8. *Ancistrolepis grammatus* Dall, alt. 101 mm	3
9. *Mohnia micra* Dall, alt. 15 mm	21

PLATE 31

		Page
FIG. 1.	*Buccinum epistomium* Dall, alt. 57 mm	7
2.	*Antiplanes bulimoides* Dall, alt. 32 mm	4
3.	*Volutopsius hirasei* Pilsbry, alt. 74 mm	30
4.	*Lacuna unifasciata* Carpenter, the color markings not indicated, alt. 6 mm	18
5.	*Buccinum rossicum* Dall, alt. 70 mm	8
6.	*Turricula (Surcula) hondoana* Dall, alt. 56 mm	29
7.	*Buccinum pemphigus* Dall, alt. 63 mm	8

PLATE 32

FIG. 1.	*Plicifusus (Helicofusus) aurantius* Dall, alt. 46 mm	24
2.	*Plicifusus croceus* Dall, alt. 37 mm	25
3.	*Volutopsius minor* Dall, alt. 40 mm	30
4.	*Mohnia hondoensis* Dall, alt. 12 mm	21
5.	*Buccinum zelotes* Dall, alt. 62 mm	9
6.	*Mohnia japonica* Dall, alt. 19 mm	21
7.	*Buccinum limnoideum* Dall, alt. 40 mm	7
8.	*Basilissa (Orectospira) babelica* Dall, alt. 37 mm	5
9.	*Murex (Pteropurpura) esychus* Dall, alt. 37 mm	21
10.	*Cocculina rhyssa* Dall, dorsal view, lon. 7.6 mm	11
11.	The same, profile, lon. 7.6 mm	11
12.	*Basilissa (Orectospira) babelica* Dall, base diam. 25 mm	5

PLATE 33

FIG. 1.	*Buccinum polium* Dall, alt. 44 mm	8
2.	*Siphonaria (Liriola) thersites* Carpenter, dorsal view, lon. 9 mm	26
3.	The same in profile, lon. 9 mm	26
4.	*Buccinum opisthoplectum* Dall, alt. 40 mm	8
5.	*Buccinum suruganum* Dall, alt. 49 mm	8
6.	*Murex (Pteropurpura) esychus* Dall, apical view, diam. 25 mm	21
7.	*Plicifusus rhyssus* Dall, alt. 49 mm	25
8.	*Buccinum acutispiratum* Dall, alt. 55 mm	6
9.	*Buccinum ectomocyma* Dall, alt. 52 mm	7
10.	*Mohnia buccinoides* Dall, alt. 39 mm	21

PLATE 34

FIG. 1.	*Mohnia kurilana* Dall, alt. 14 mm	21
2.	*Lacuna solidula* Lovèn, alt. 10 mm	18
3.	*Chrysodomus eulimatus* Dall, immature specimen, but original type (*see also* Plate 14), alt. 68 mm	9
4.	*Galeodea leucodoma* Dall, alt. 67 mm	17
5.	*Ancistrolepis damon* Dall, alt. 80 mm	3
6.	*Liomesis bistriatus* Dall, alt. 18 mm	18
7.	*Plicifusus polypleuratus* Dall, alt. 29 mm	25

PLATE 35

FIG. 1.	*Cymatium adairense* Dall, alt. 34 mm	16
2.	*Corbicula (Cyanocyclas) oleana* Marshall, alt. 14 mm	15
3.	*Volutharpa ampullacea* Middendorff, var. *acuminata* Dall, alt. 25 mm	30

		Page
FIG. 4.	*Astraea persica* Dall, profile, diam. 22 mm	5
5.	*Strombina lilacina* Dall, alt. 23.5 mm	27
6.	*Astraea persica* Dall, top view, diam. 22 mm	5
7.	*Turris? simplicissima* Dall, alt. 25 mm	30
8.	*Chrysodomus (Sulcosipho?) adelphicus* Dall, alt. 56 mm	9
9.	*Buccinum nipponense* Dall, alt. 57 mm	7
10.	*Ancistrolepis decora* Dall, alt. 58 mm	3

PLATE 36

FIG. 1.	*Turbo asteriola* Dall, alt. 13.5 mm	28
2.	*Microgaza fulgens* Dall, profile, diam. 10.5 mm	20
3.	*Liotia lurida* Dall, diam. 15 mm	19
4.	*Margarites beringensis* E. A. Smith, basal view, diam. 11.6 mm	19
5.	*Coralliophila spinosa* Dall, alt. 37 mm	14
6.	*Margarites beringensis* E. A. Smith, profile, diam. 11.6 mm	19
7.	*Turbo asteriola* Dall, basal view, diam. 20 mm	28
8.	*Coralliophila spinosa* Dall, apical view, diam. 25 mm	14
9.	*Bolma bartschi* Dall, alt. 30 mm	6
10.	*Microgaza fulgens* Dall, basal view, diam. 14 mm	20
11.	*Turcicula japonica* Dall, alt. 23 mm	29

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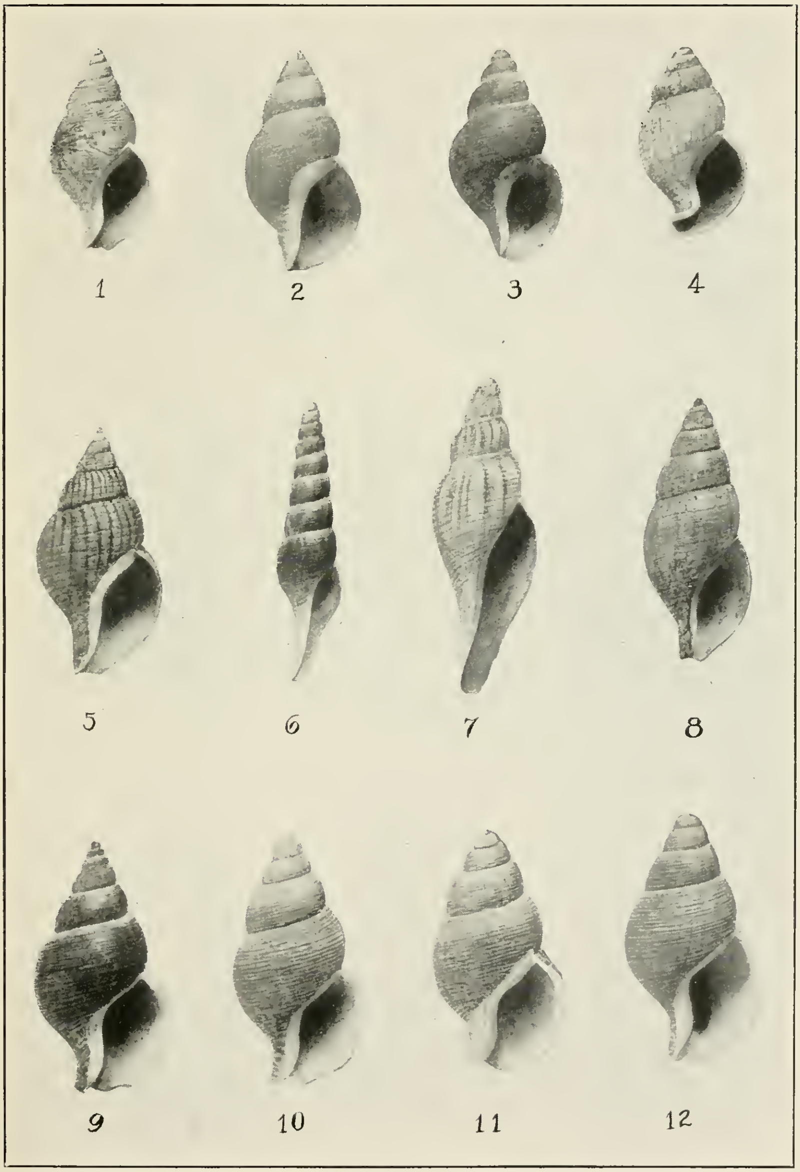

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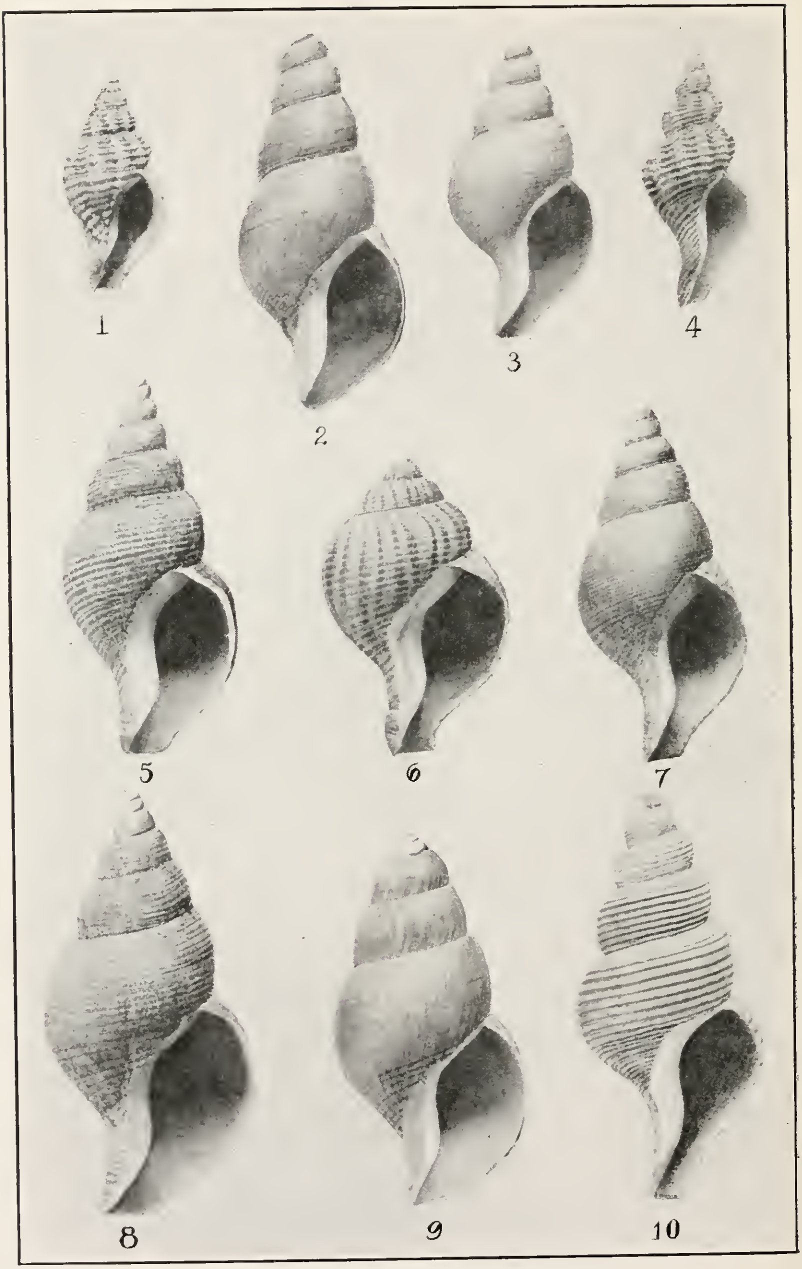

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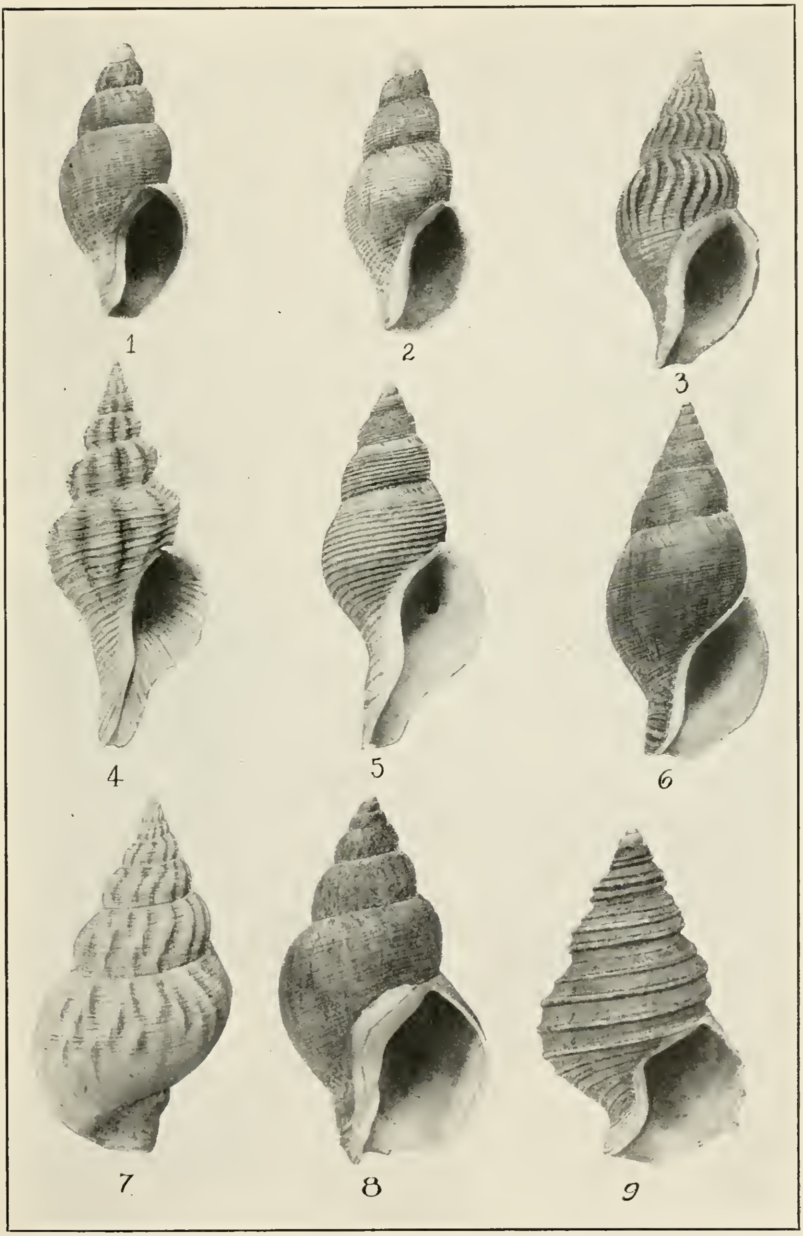

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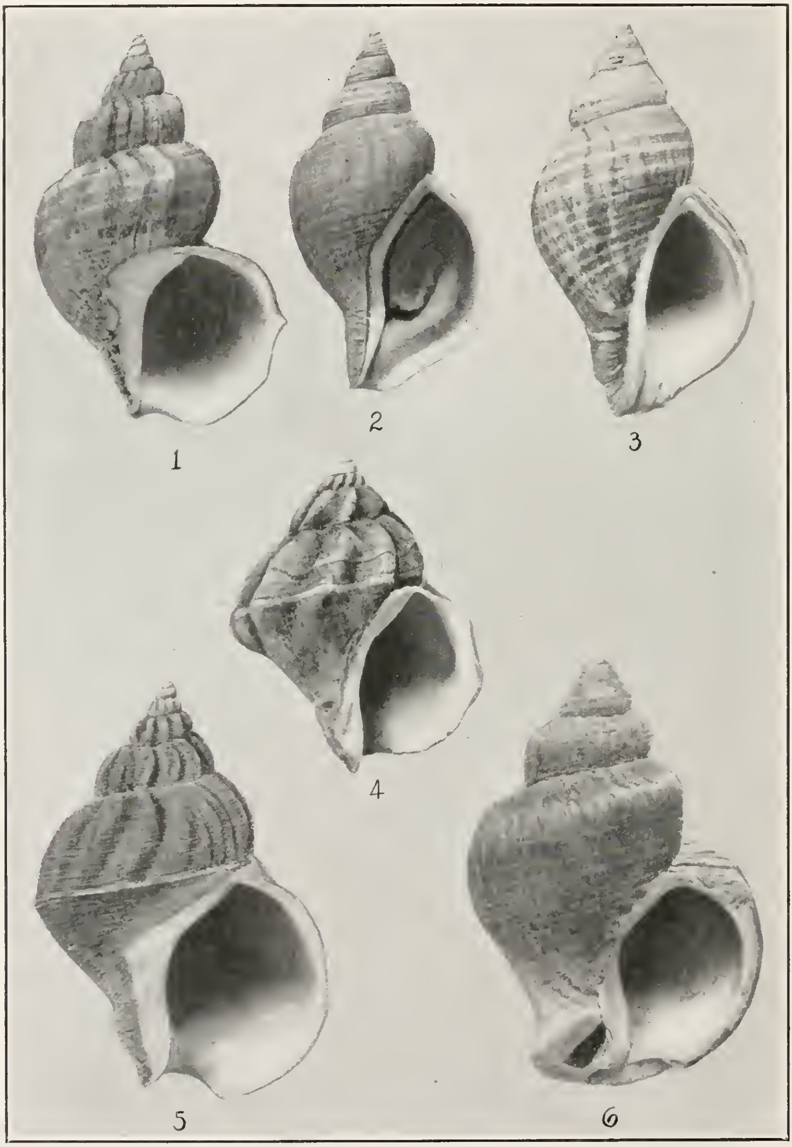

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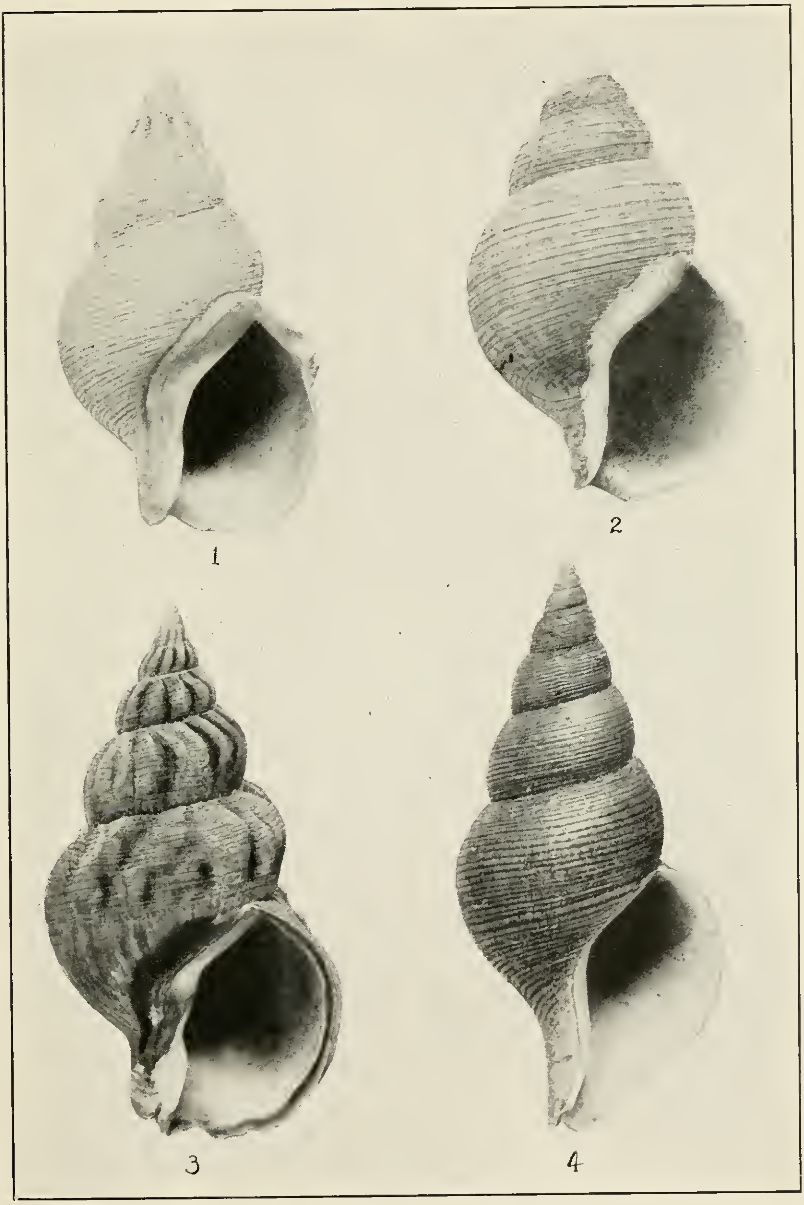

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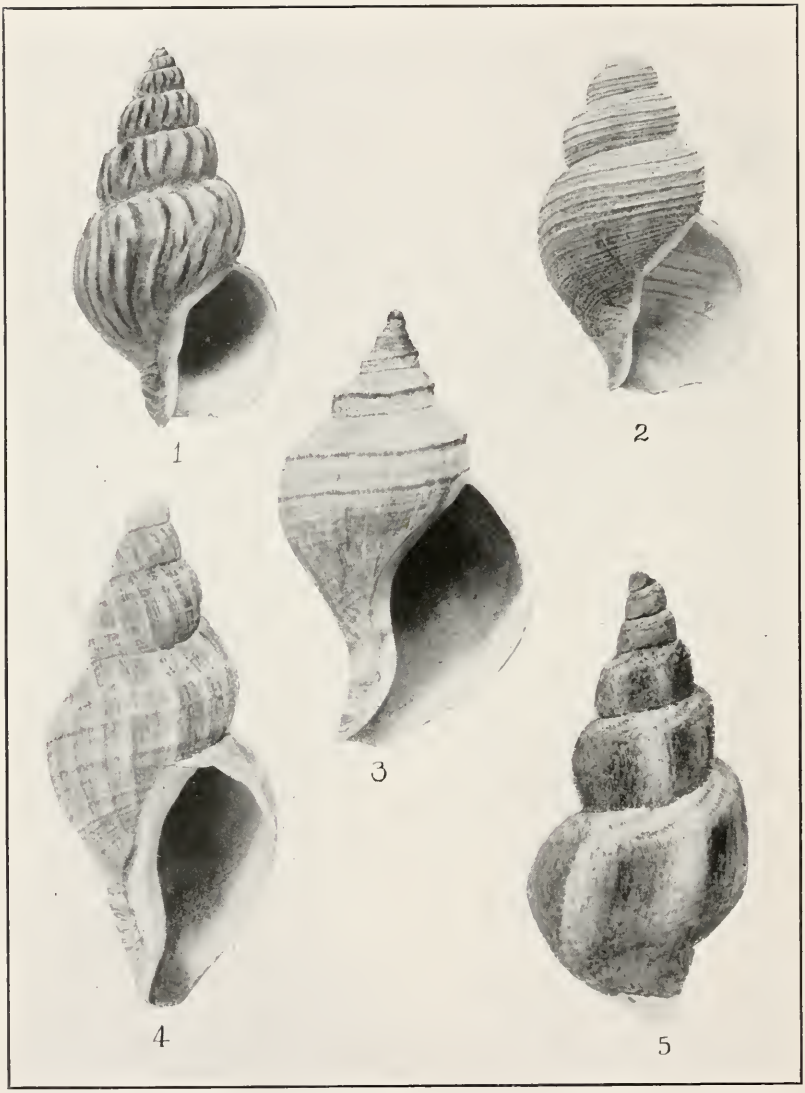

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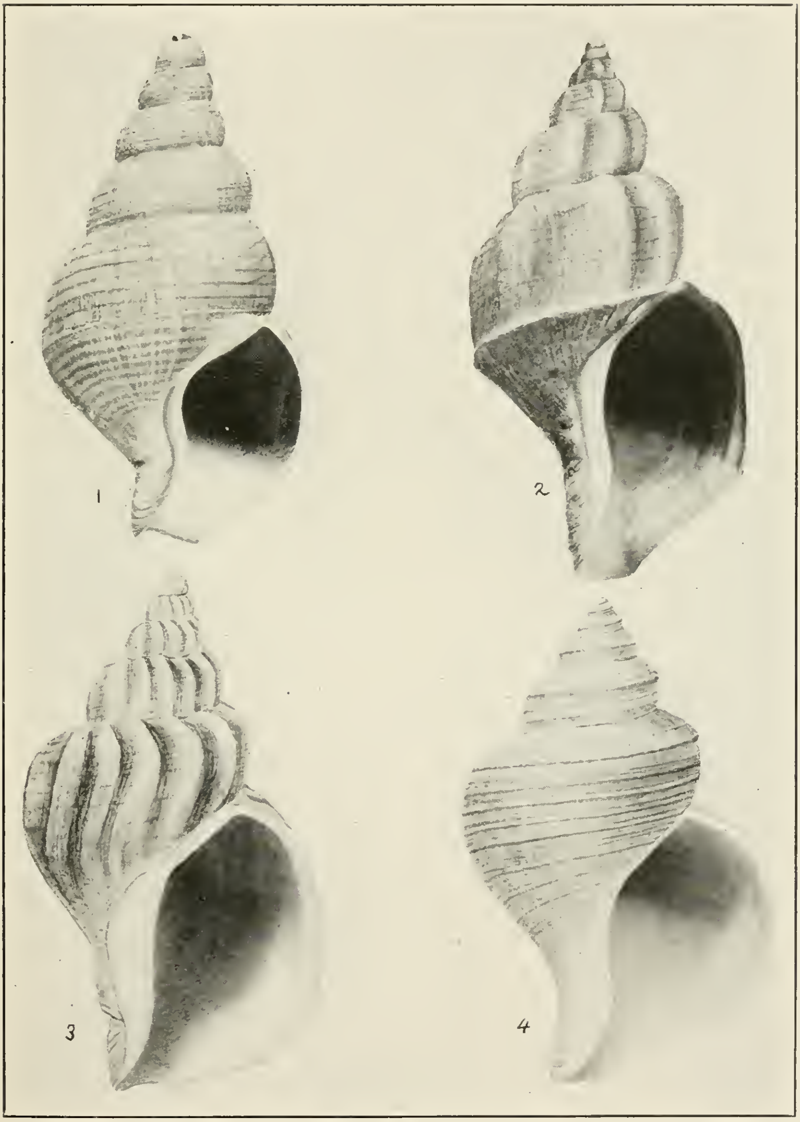
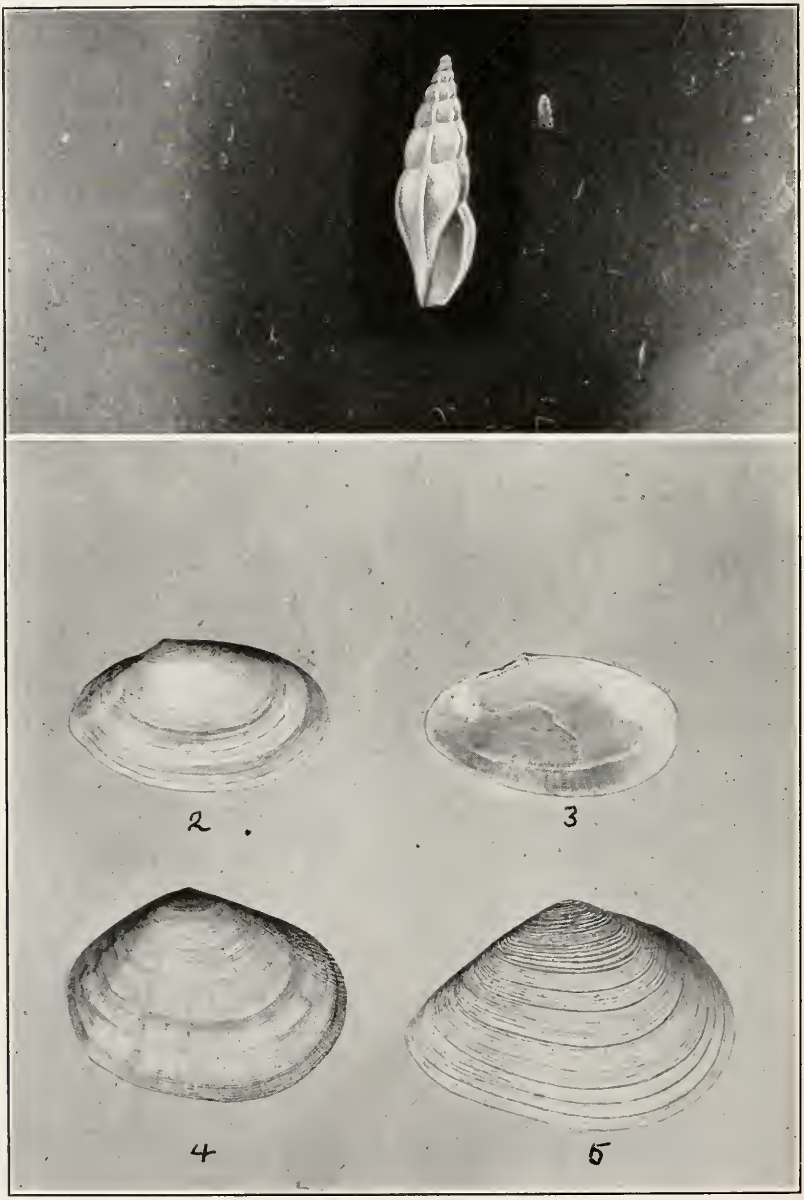


Illustrations of Types

For explanation of plate see page 36



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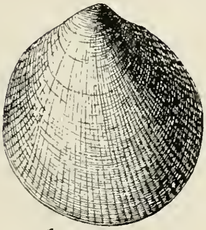

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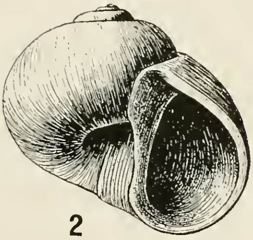

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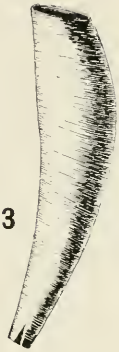

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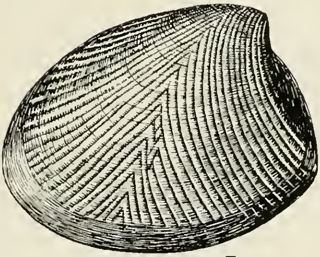

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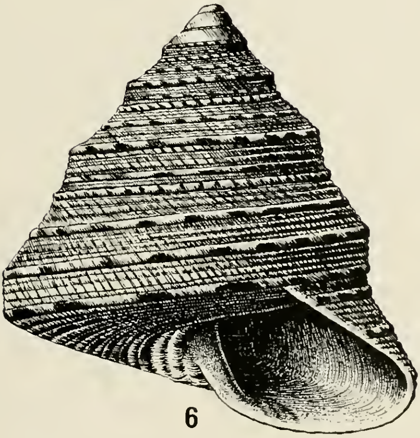

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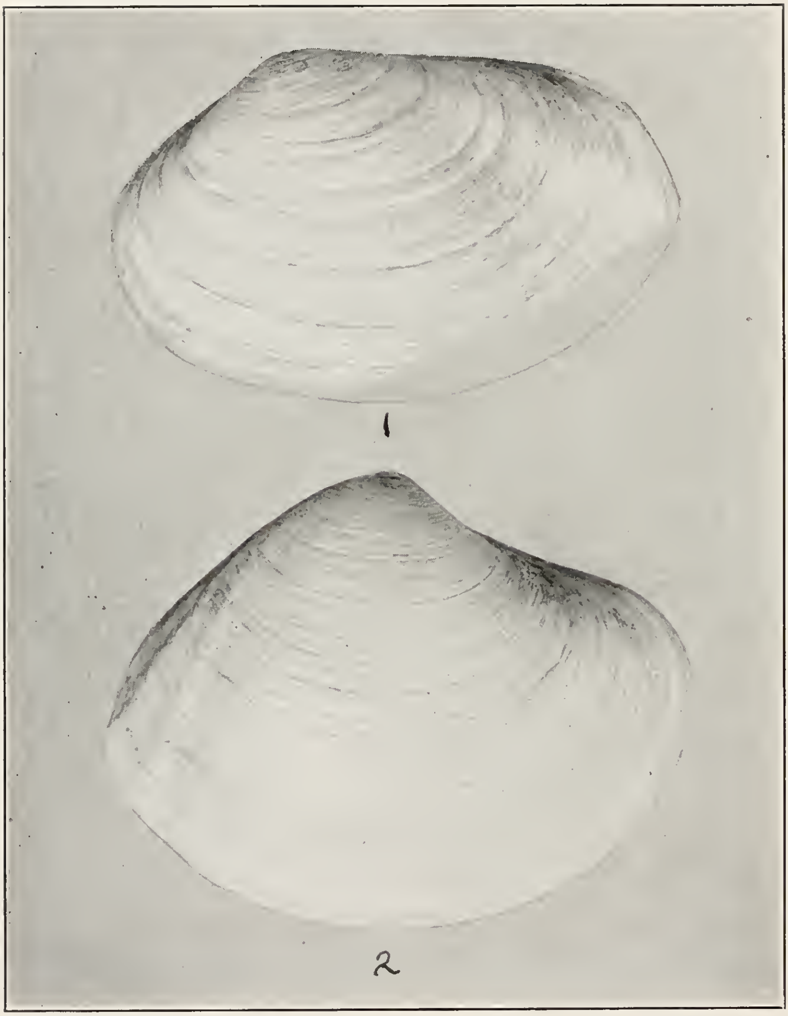

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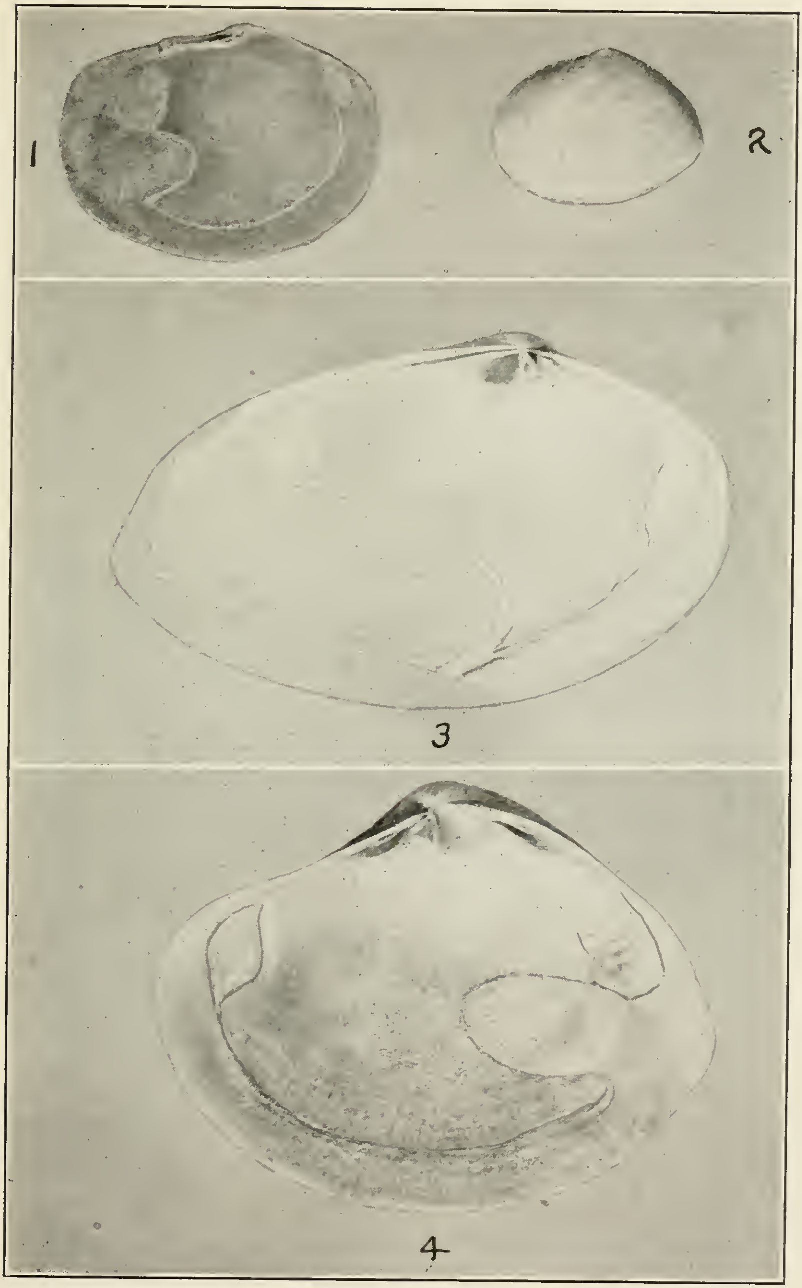

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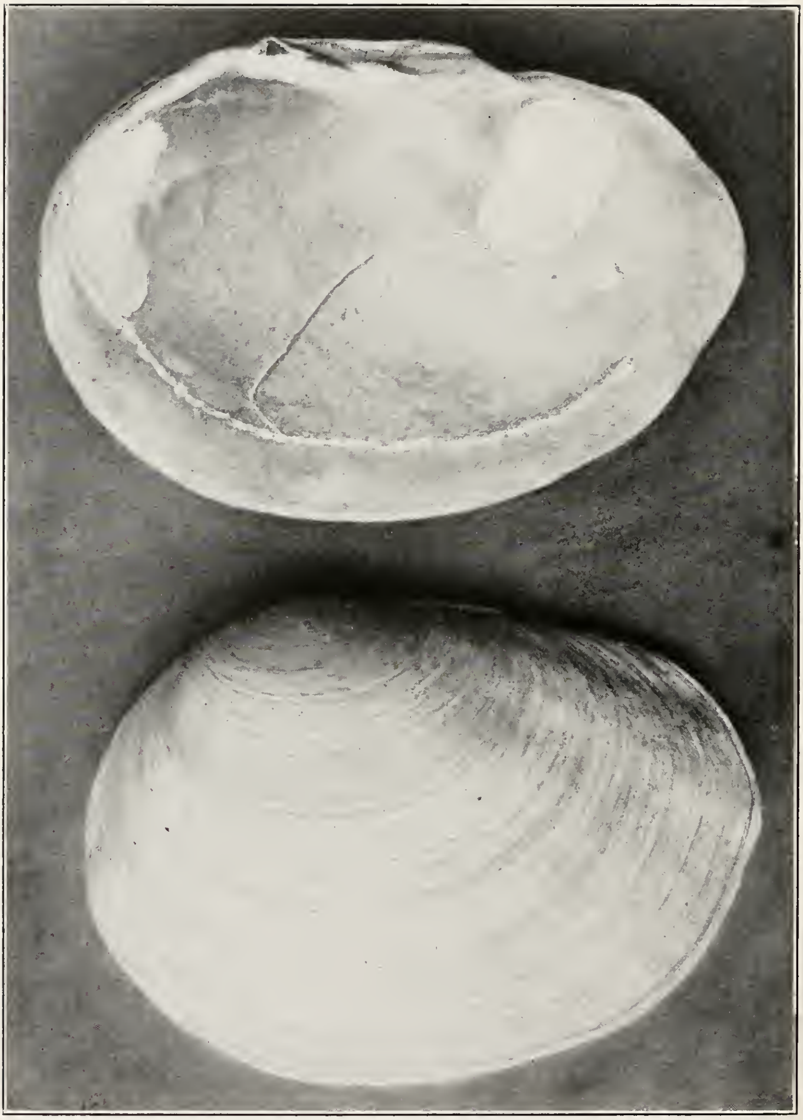

SANGUINOLARIA ORCUTTI DALL

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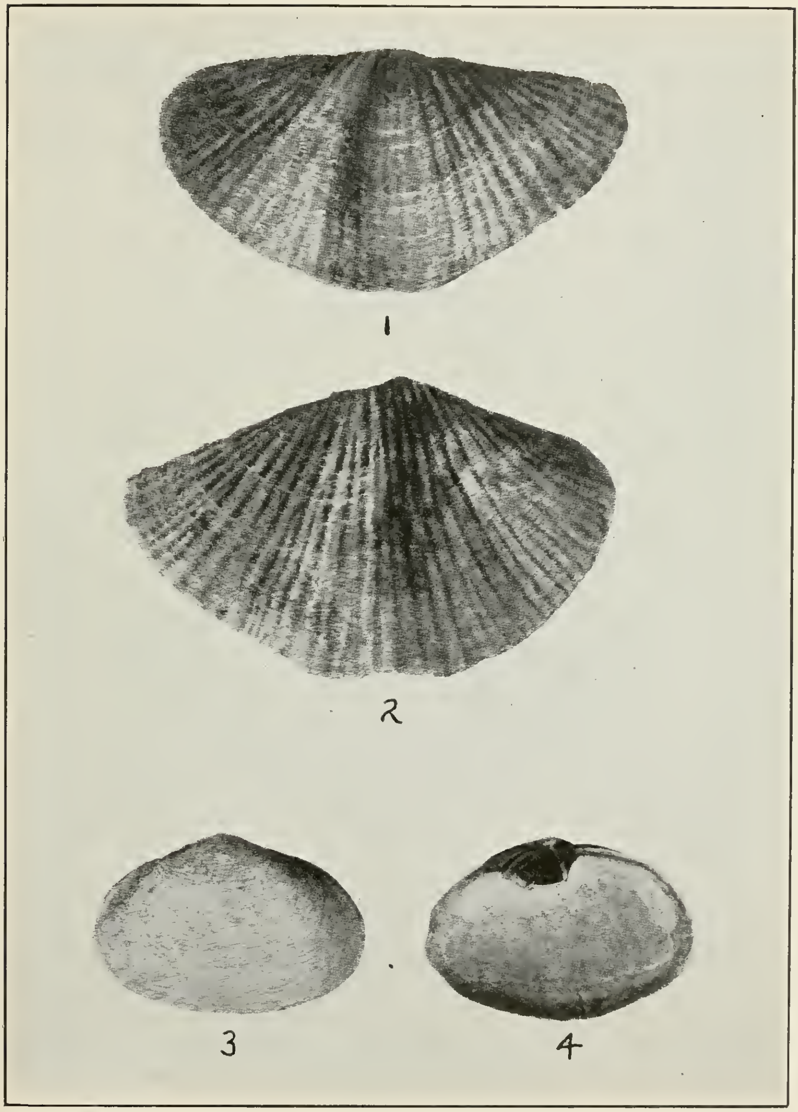

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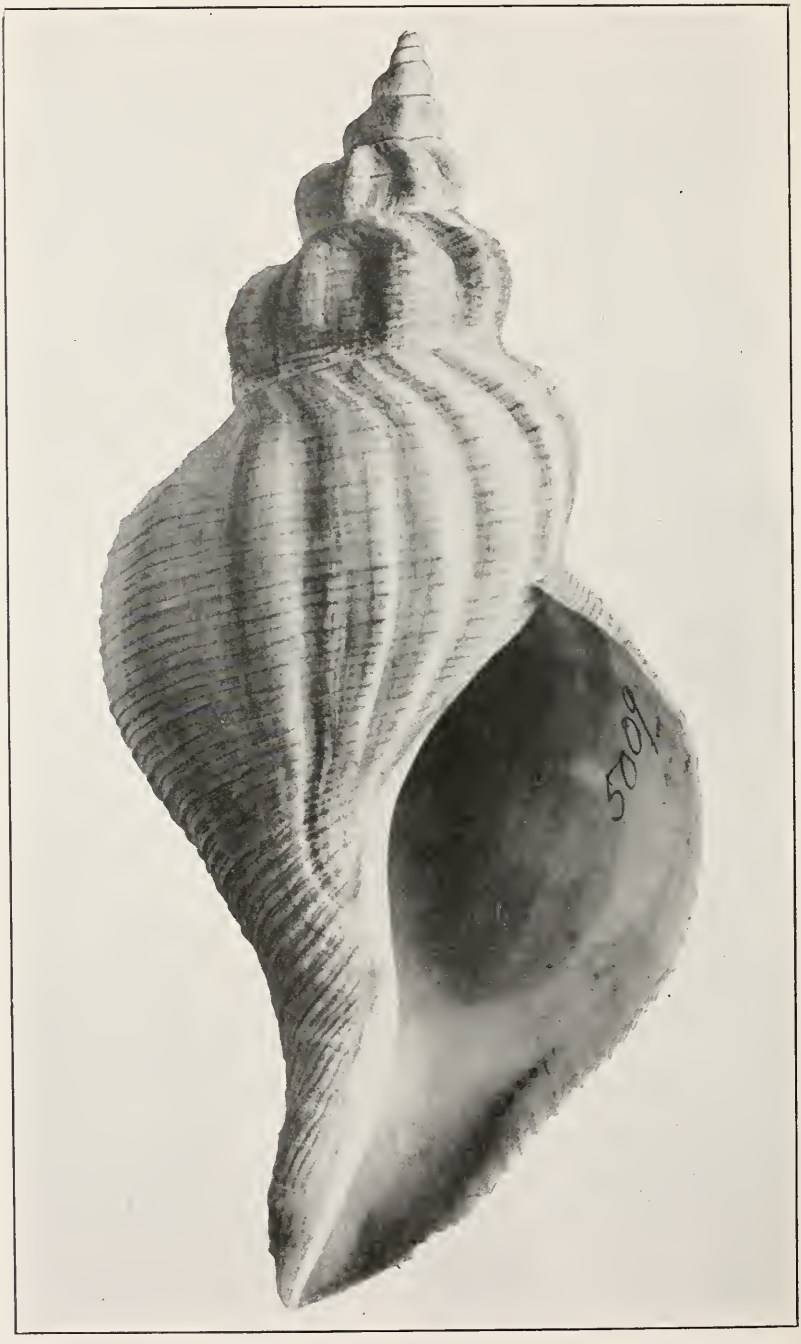

CHRYSODOMUS EULIMATUS DALL

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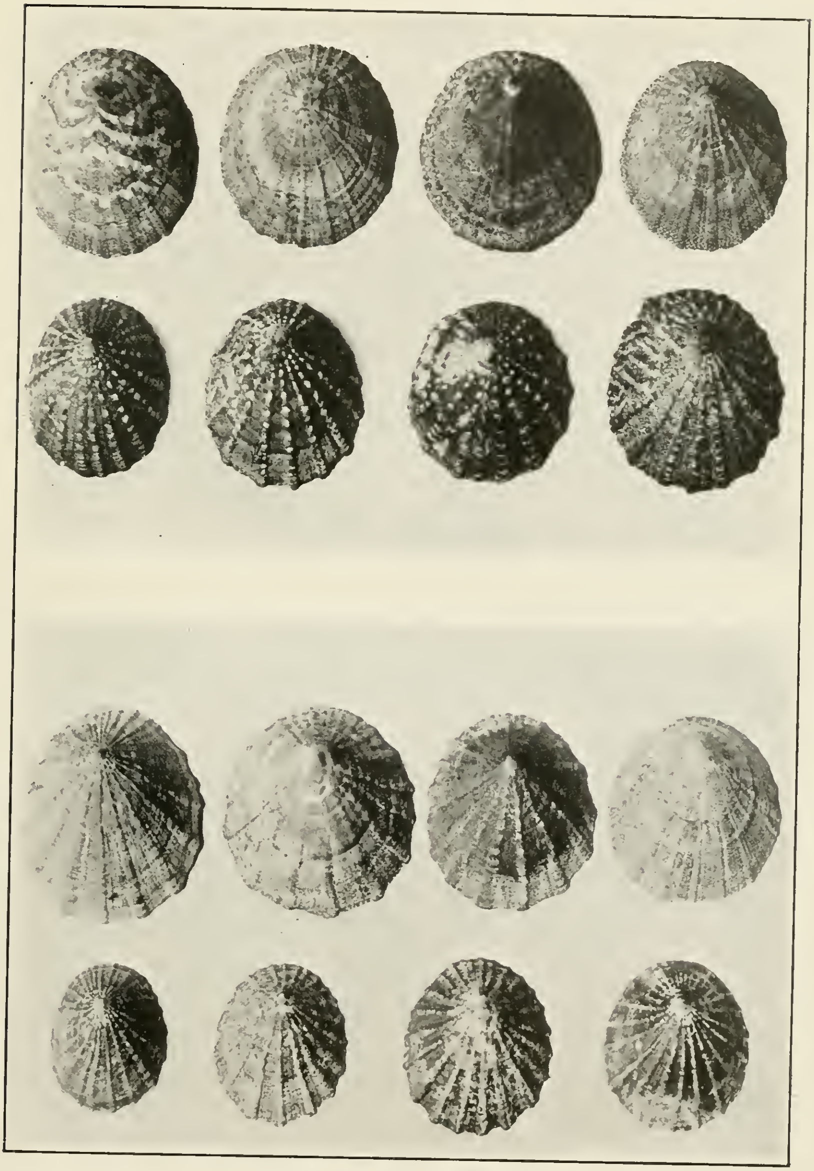

ACMAEA DIGITALIS ESCHSCHOLTZ

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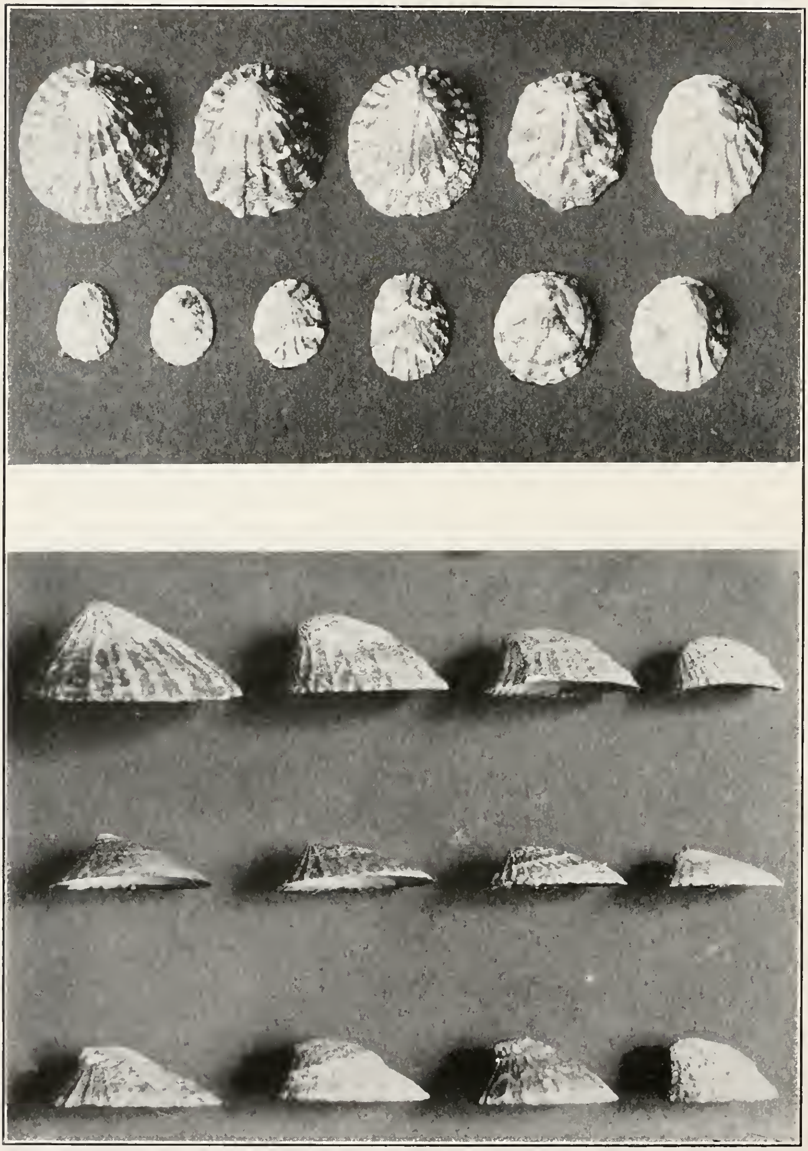

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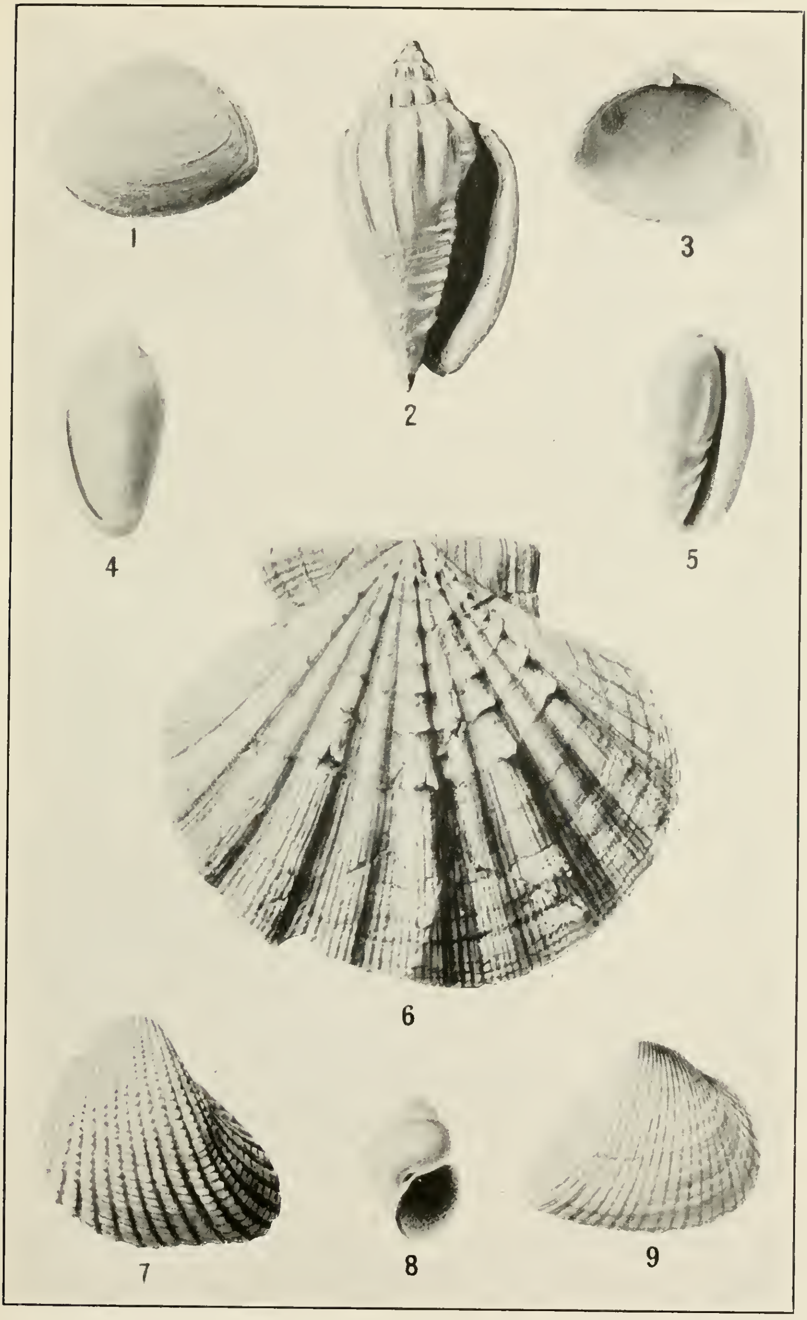

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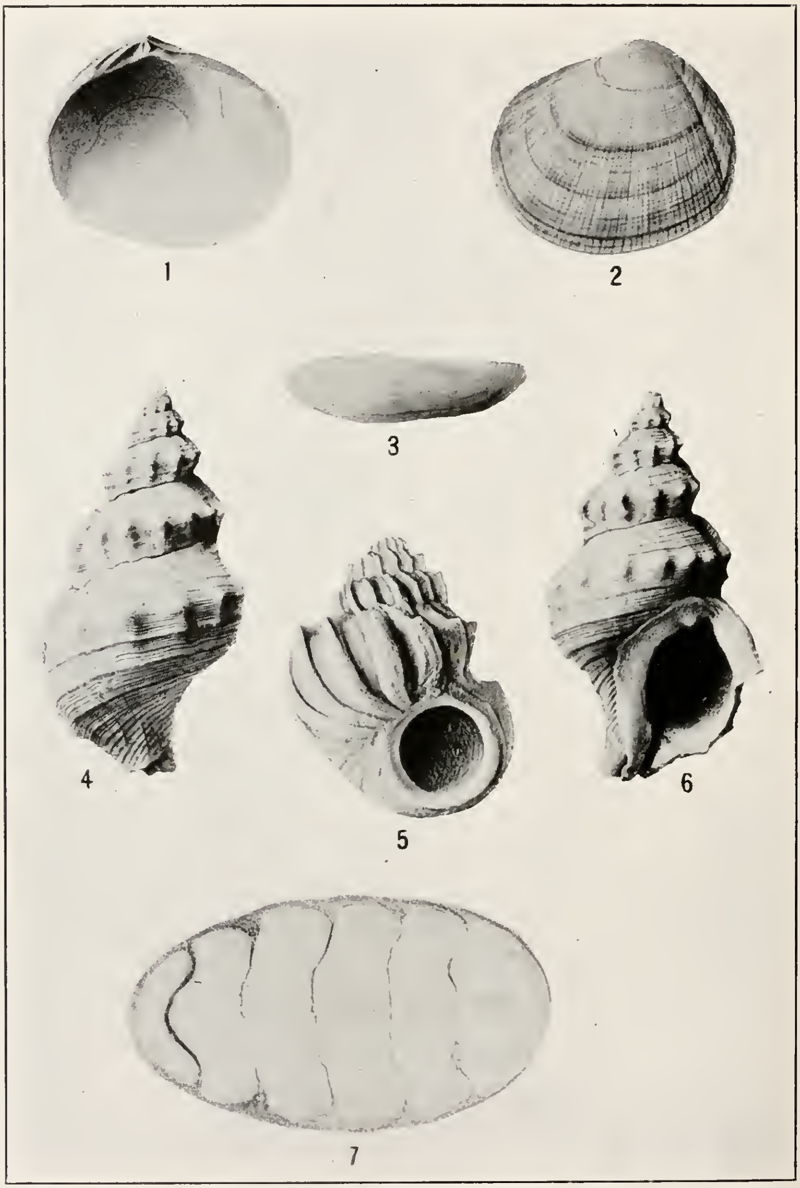

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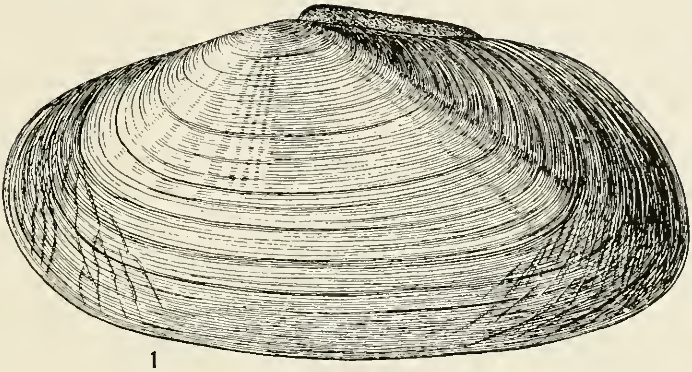

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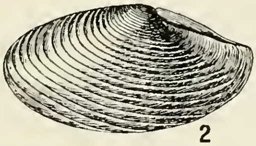

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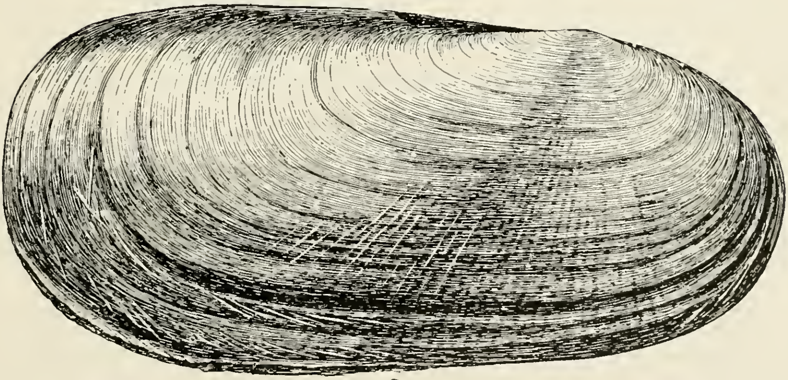

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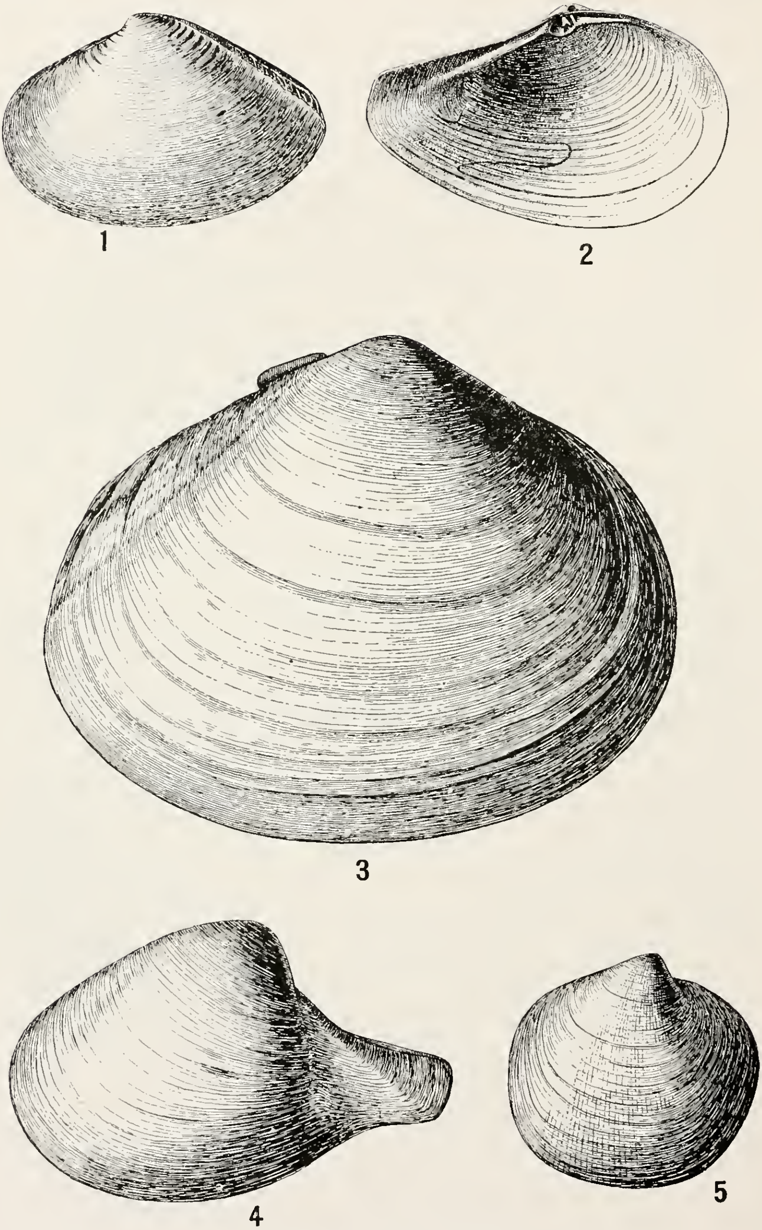

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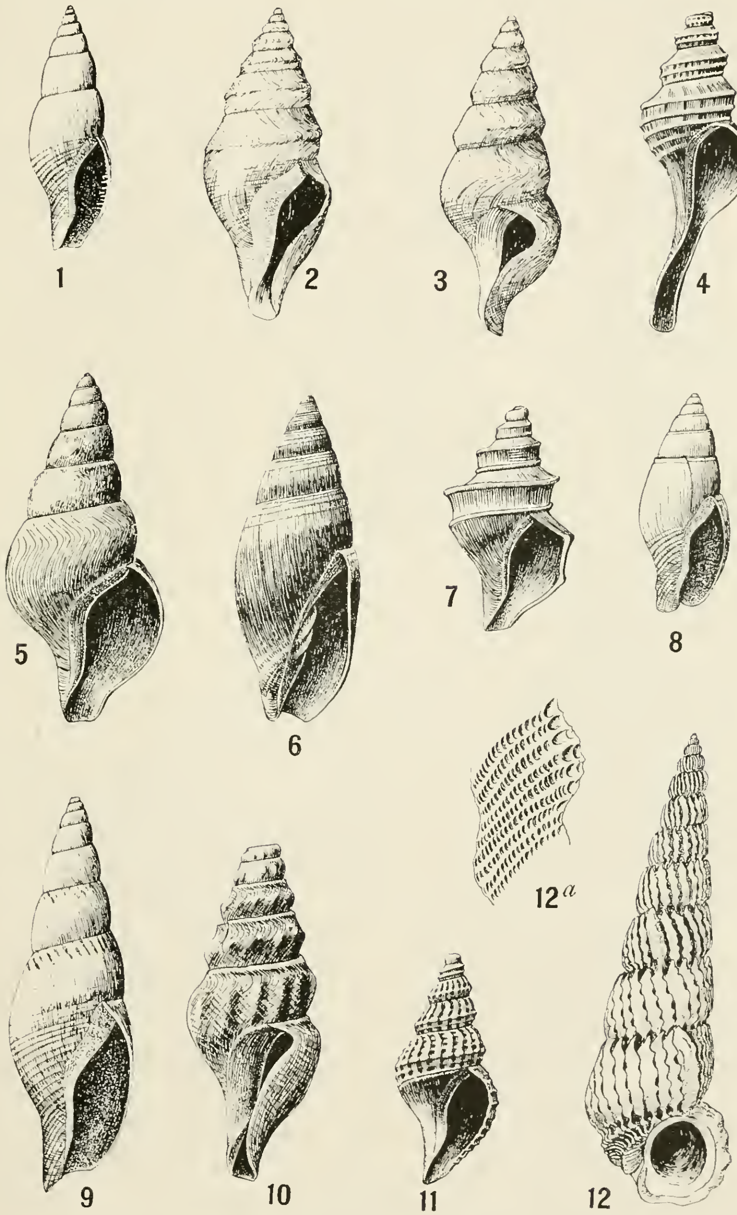

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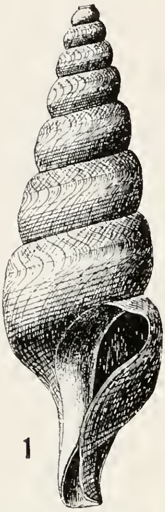

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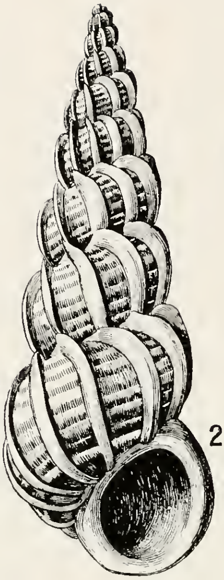

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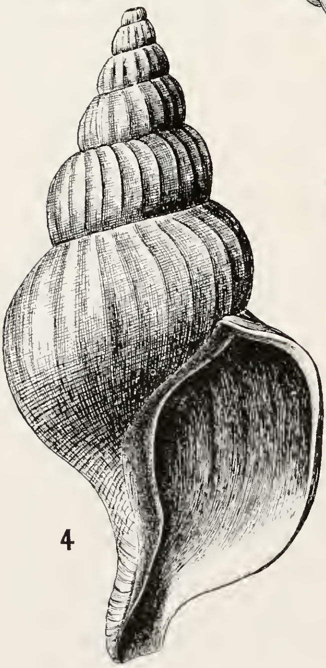

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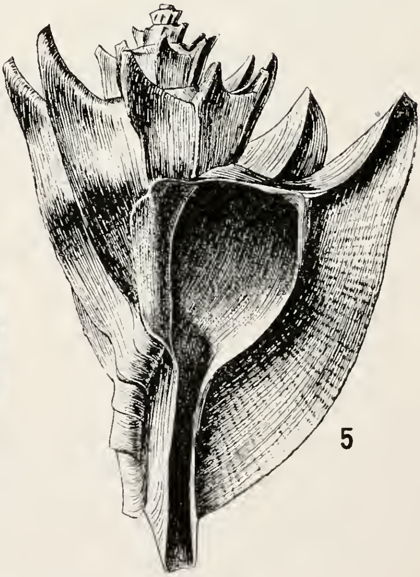

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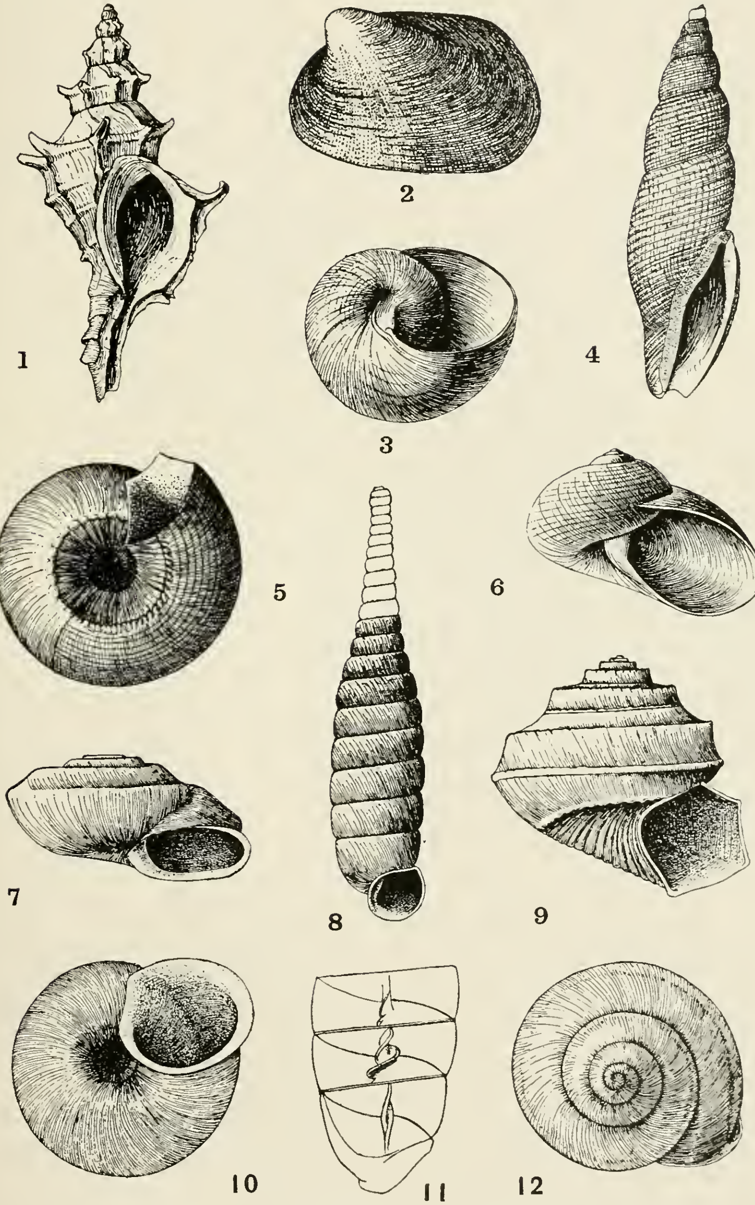
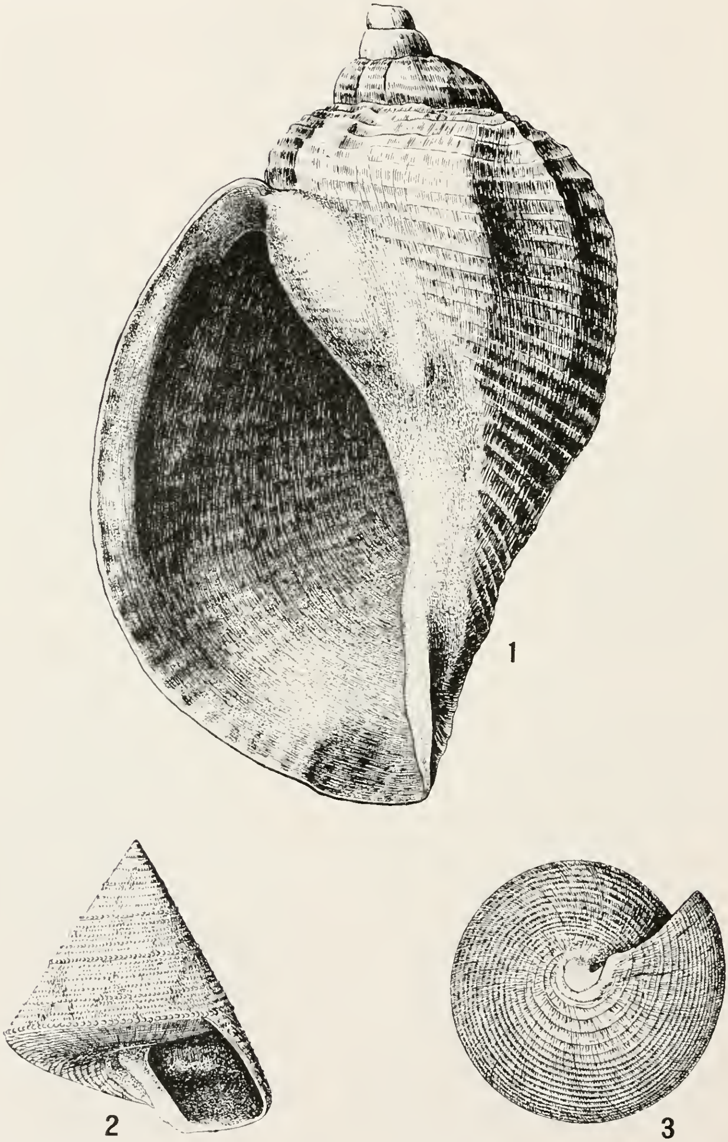
ILLUSTRATIONS OF TYPES

FOR EXPLANATION OF PLATE SEE PAGE 38



Illustrations of Types

For explanation of plate see page 33



ILLUSTRATIONS OF TYPES

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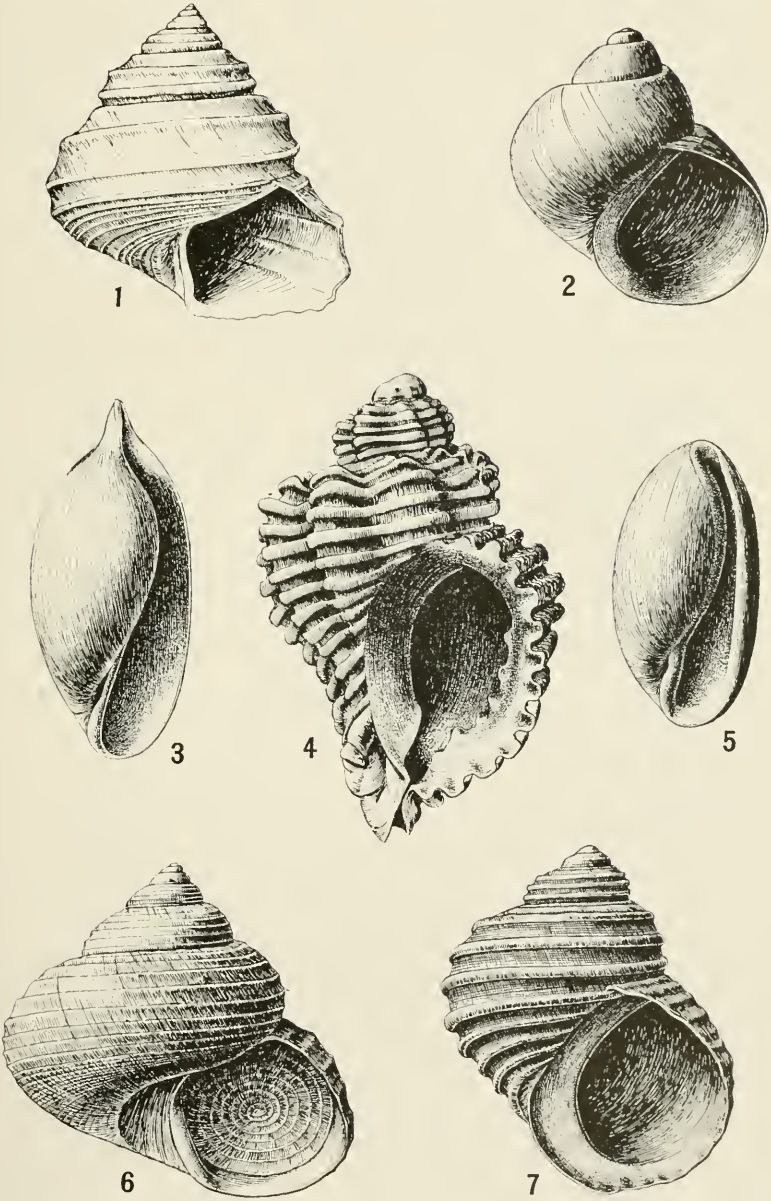

ILLUSTRATIONS OF TYPES

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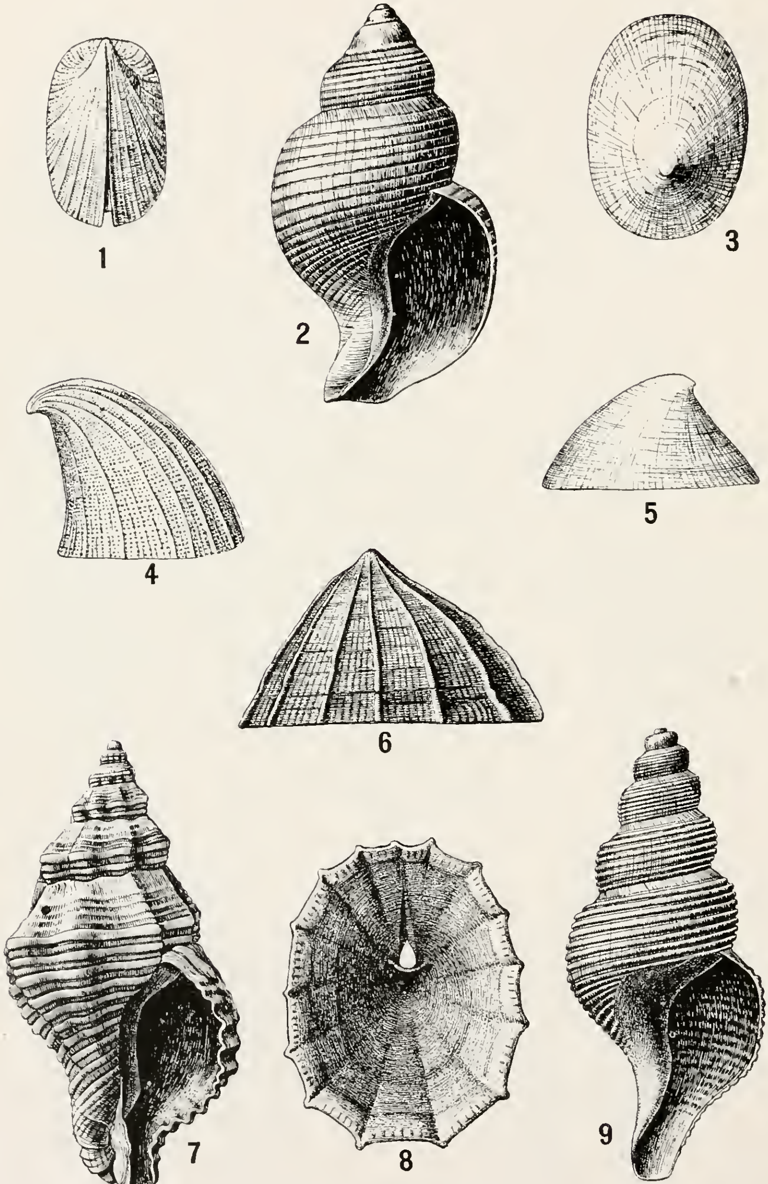
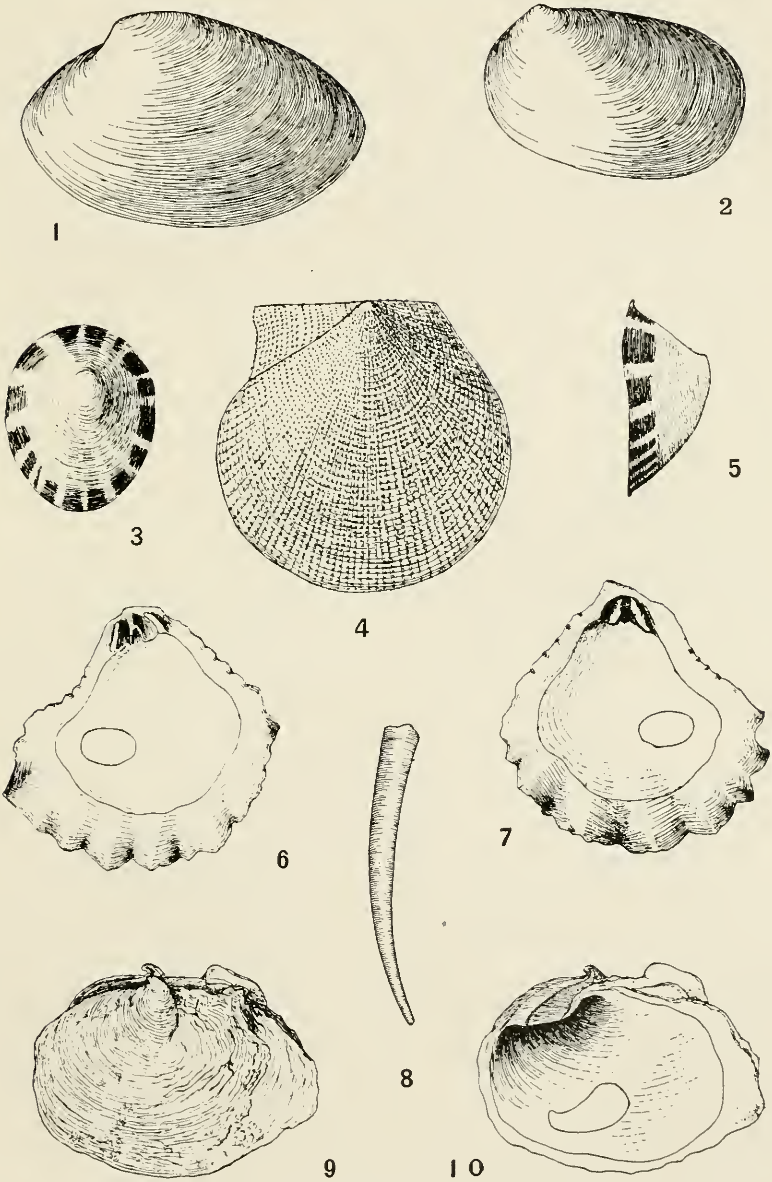


ILLUSTRATIONS OF TYPES

FOR EXPLANATION OF PLATE SEE PAGES 38 AND 39



ILLUSTRATIONS OF TYPES

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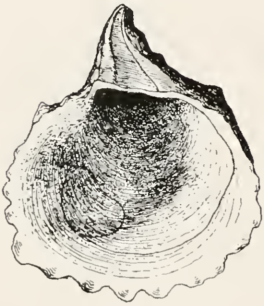

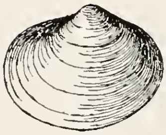

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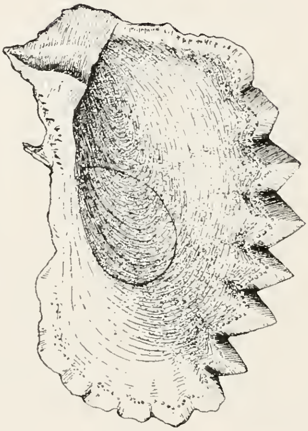

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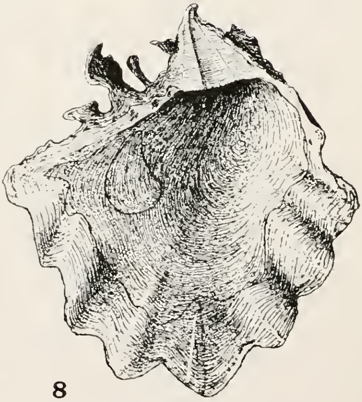

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ILLUSTRATIONS OF TYPES

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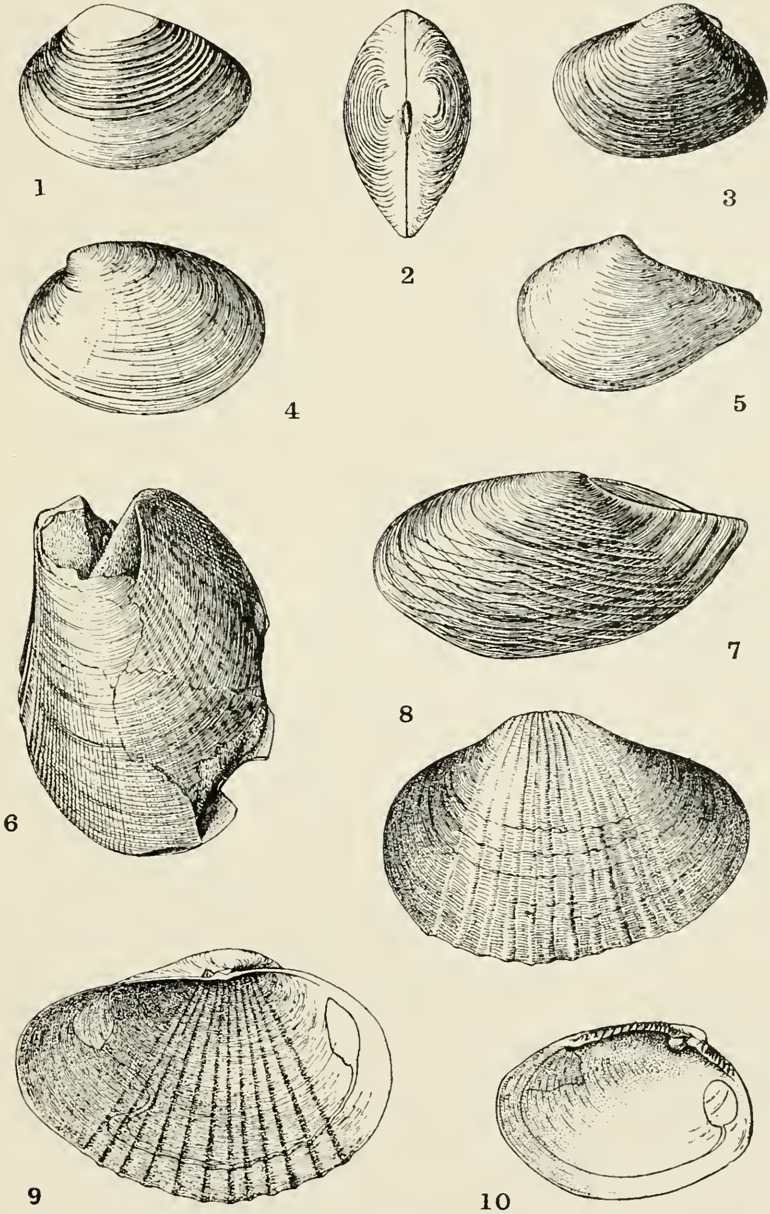

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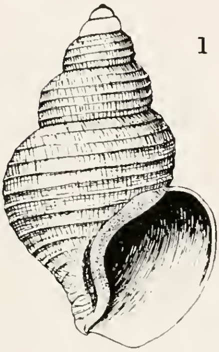

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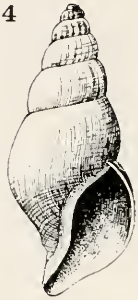

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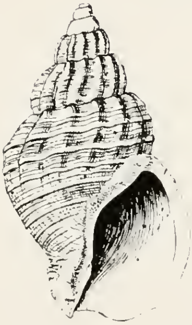

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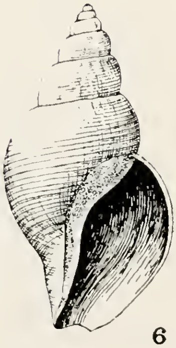

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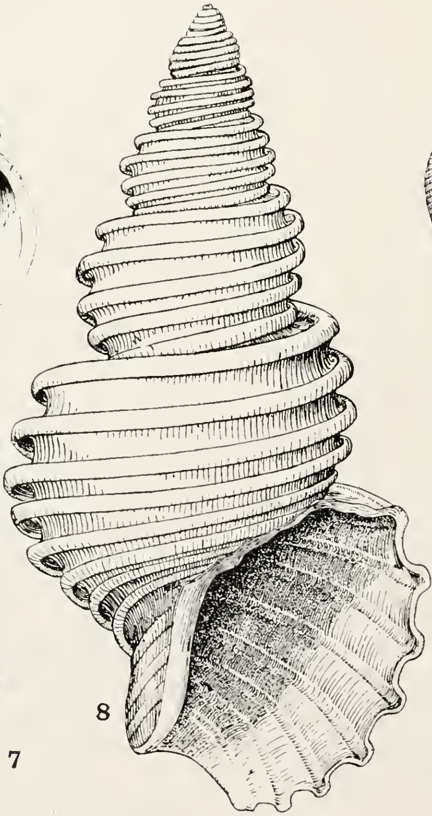

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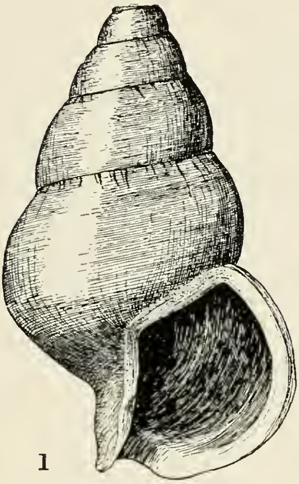
ILLUSTRATIONS OF TYPES

FOR EXPLANATION OF PLATE SEE PAGE 39



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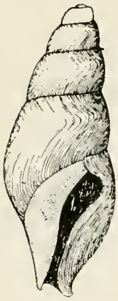

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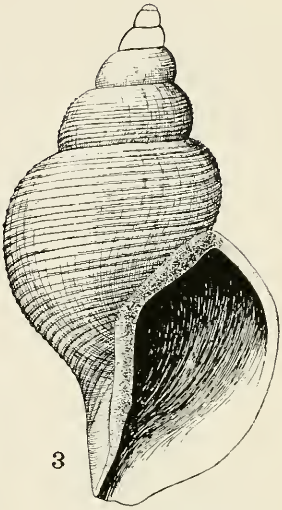

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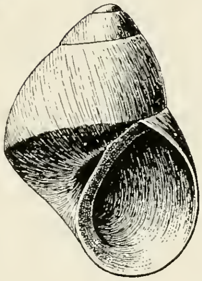

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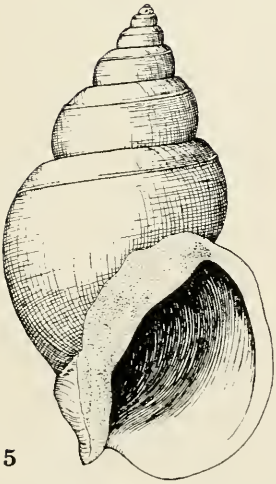

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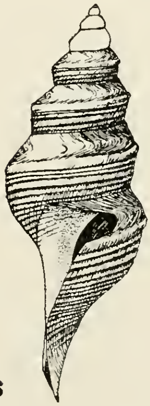

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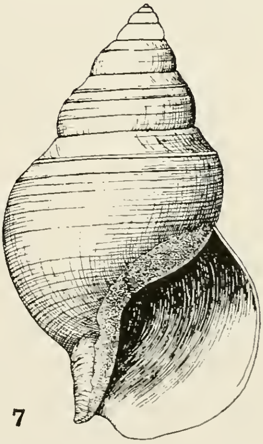

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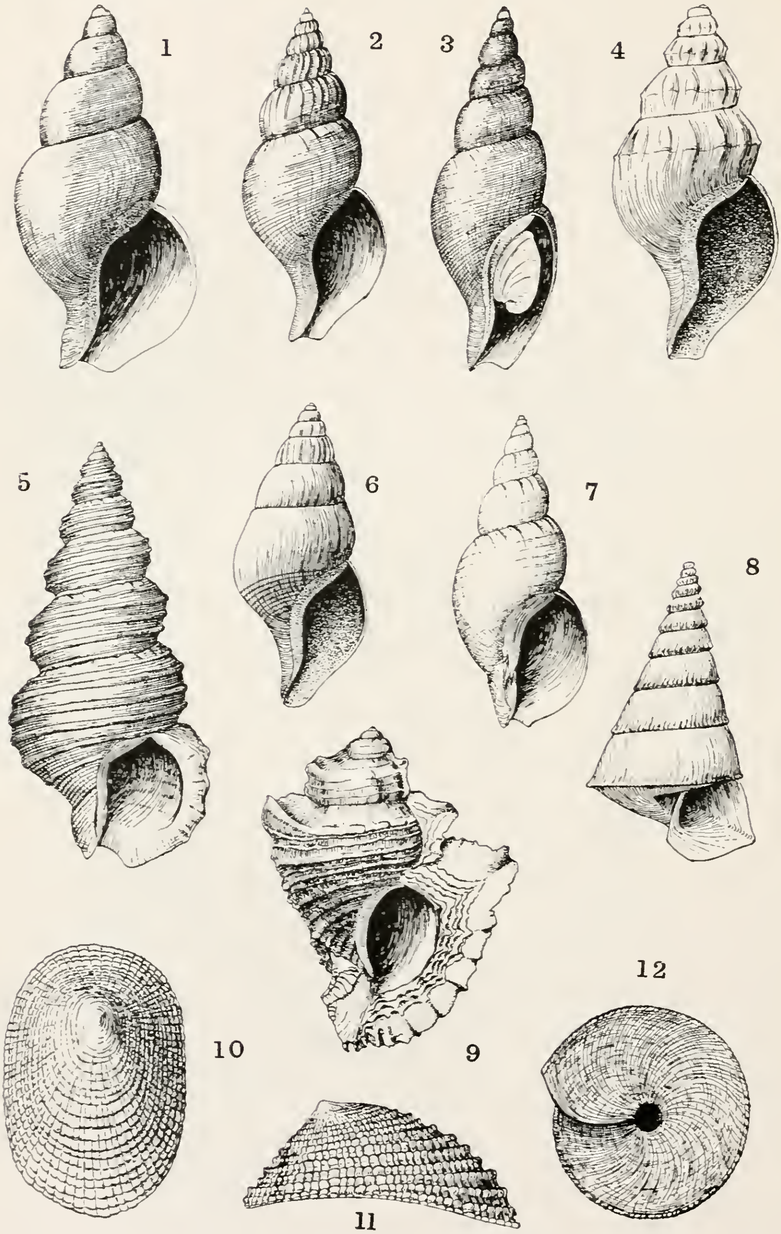
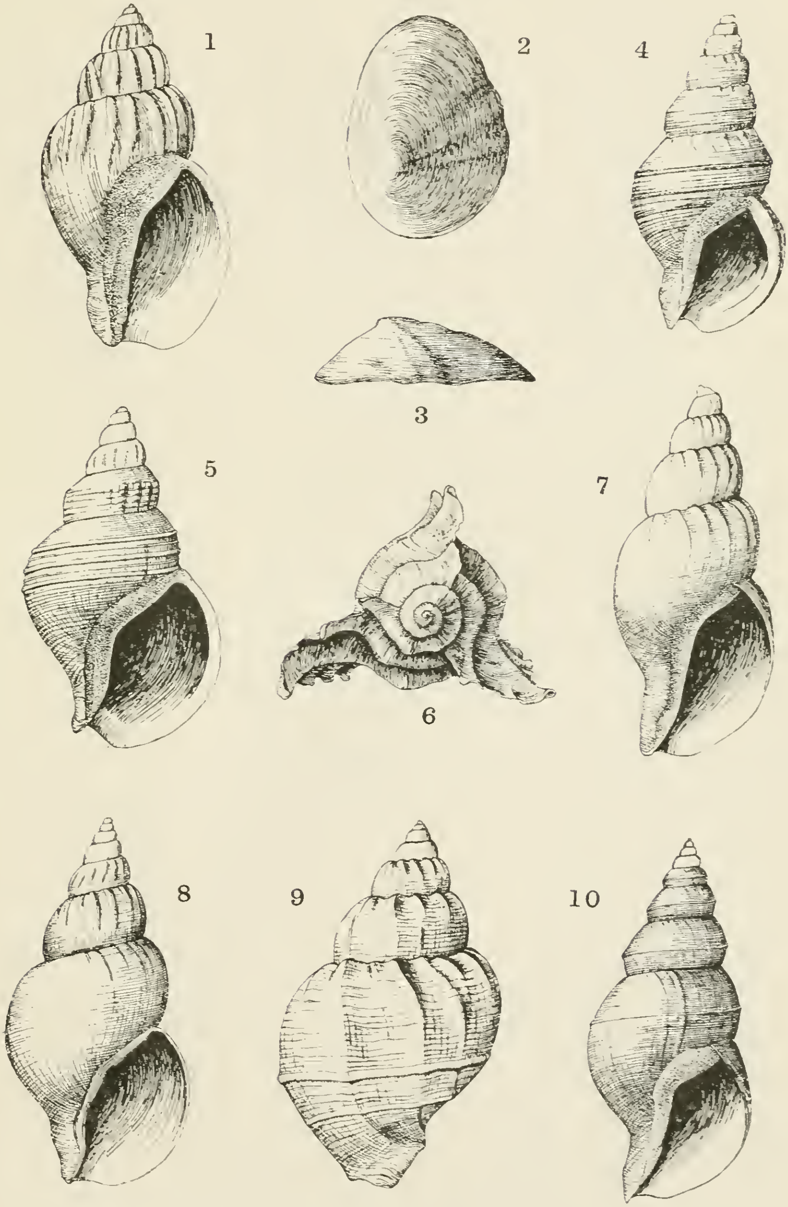
ILLUSTRATIONS OF TYPES

FOR EXPLANATION OF PLATE SEE PAGE 40



ILLUSTRATIONS OF TYPES

FOR EXPLANATION OF PLATE SEE PAGE 40



ILLUSTRATIONS OF TYPES

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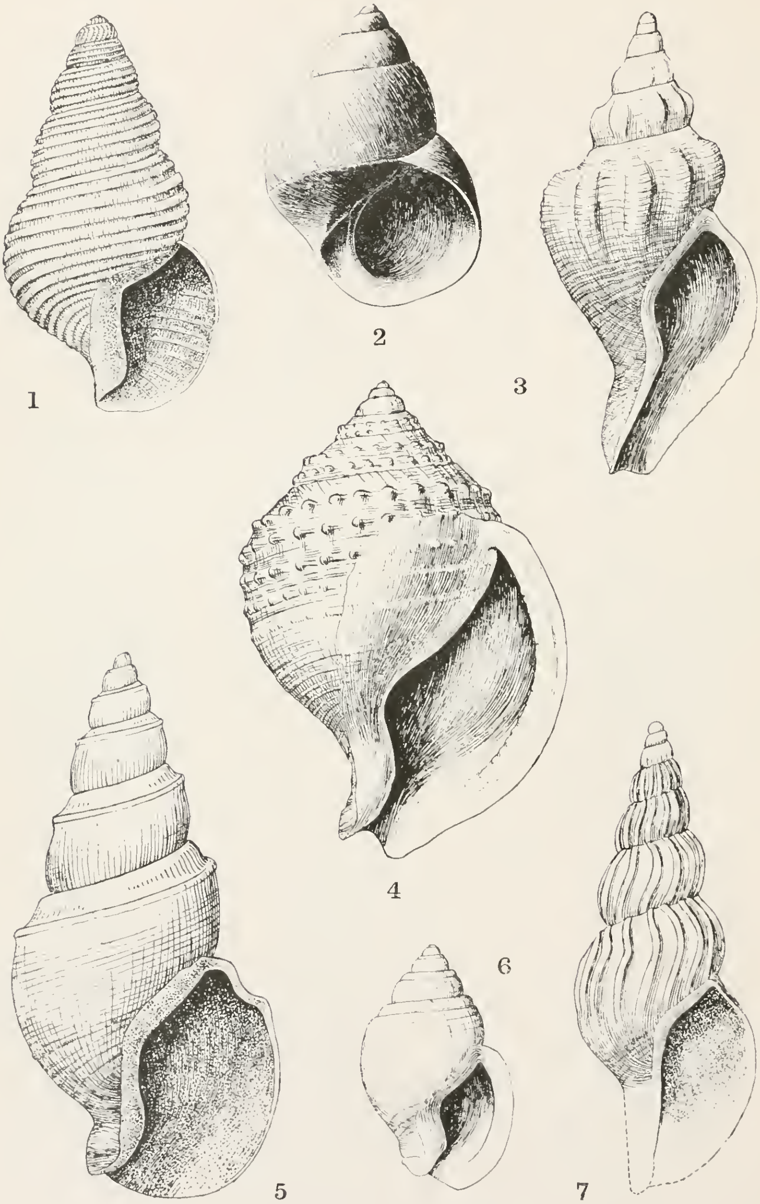

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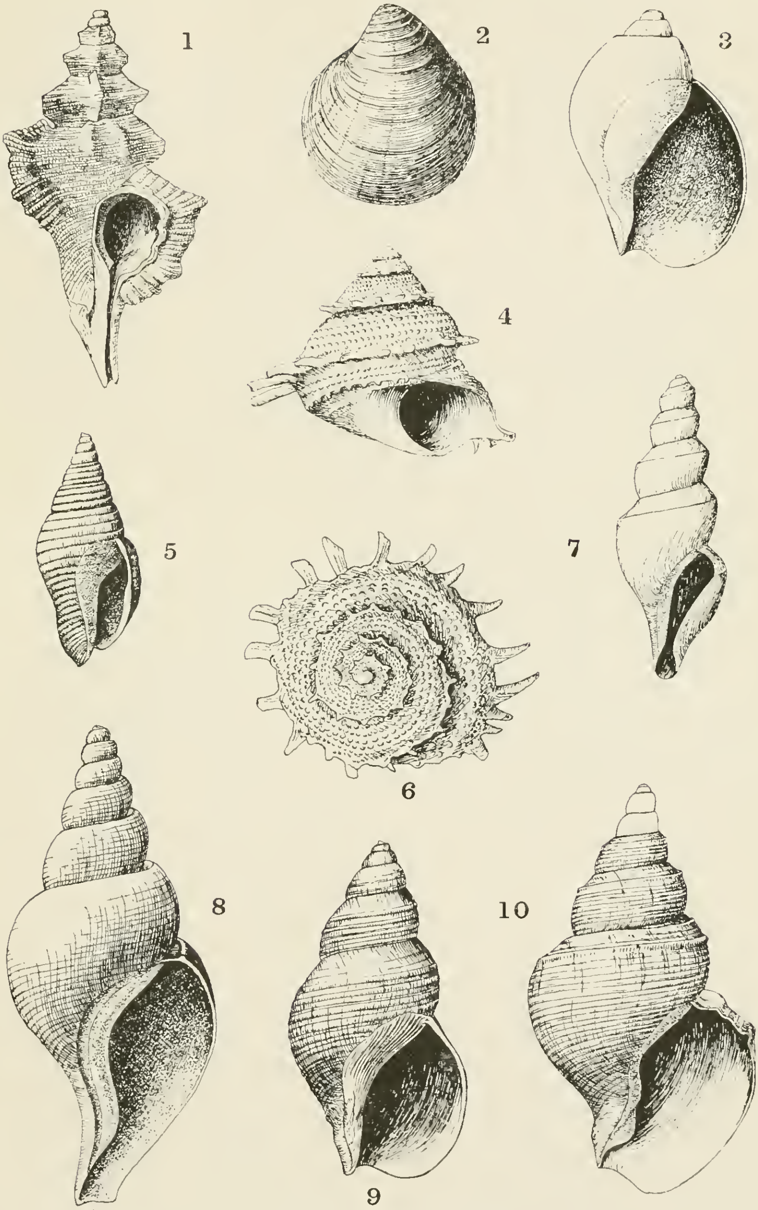

ILLUSTRATIONS OF TYPES

FOR EXPLANATION OF PLATE SEE PAGES 40 AND 41


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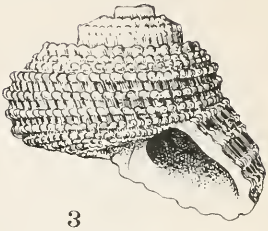
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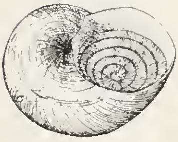
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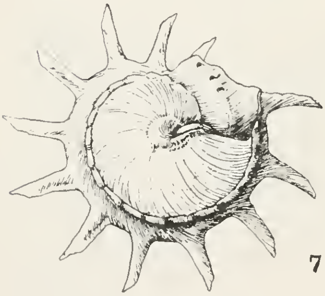
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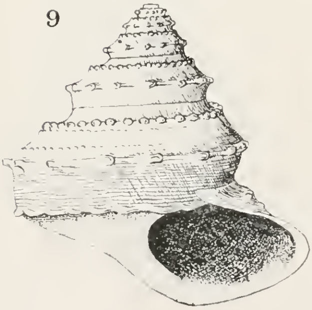
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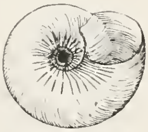
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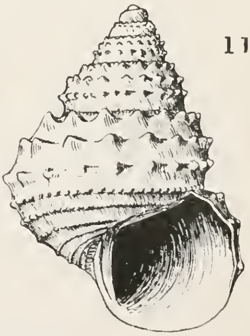
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ILLUSTRATIONS OF TYPES

FOR EXPLANATION OF PLATE SEE PAGE 41

NEW DIPTERA OR TWO-WINGED FLIES IN THE UNITED STATES NATIONAL MUSEUM

By J. M. Aldrich

Associate Curator, Division of Insects, United States National Museum

The following descriptions of two new genera and 26 new species of Diptera, with notes on little-known species and several tables of species and genera, are the result of general work on the collection in this order.

Family MILICHIIDAE

Genus PHOLEOMYIA Hendel

Pholeomyia Bilimek, Verh. Zool.-Bot. Ges. Wien, p. 903, 1867.—Hendel, Wien. Ent. Zeit., vol. 30, p. 40, 1911.—Melander, Journ. N. Y., Ent. Soc., vol. 21, pp. 234–238, 1913.—Malloch, Proc. U. S. Nat. Mus., vol. 46, pp. 130–134, 1913.

Rhynchomilichia Hendel, Wien. Ent. Zeit., vol. 22, p. 250, 1903.

PHOLEOMYIA EXPANSA, new species

Male.—Dull black in color, the abdomen expanded and circular in outline, silvery-white except on basal segment.

Front brownish black, slightly converging toward the antennae, where it is about one-fourth the width of the head. Besides the orbital row of bristles, which extends slightly below the attachment of the antennae, there are two variable rows of small bristles or hairs beginning just below the lowest ocellus and converging so as to unite at the lunule. Antennae black, the third joint round; arista short; vibrissae about the middle of the face, close to the eyes, separated by twice the greatest diameter of the third antennal joint; palpi black; proboscis not very long; the labella folding back, as long as the preceding segment. Thorax with well developed chaetotaxy: dorsocentrals 4; acrostichals 3 or 4 pairs behind the suture, the hindmost large; humeral 2; presutural 2; notopleural 2; supraalar 2; intraalar 2 or 3; scutellum with 2 pairs; mesopleura with a cluster of about 8; sternopleura with 3. Halteres black including stem. Calypters brown with blackish rim and brownish fringe. Abdomen

circular, very thin and flat, the dorsal surface entirely silvery, but under a high power showing a single row of delicate black hairs along the hind margin of each segment. First abdominal segment dull black, venter black, the sternites narrow, the membrane greatly developed between them and the tergites, so as to cover almost the whole. Wings sometimes milky, usually subhyaline, the veins black; the costa deeply and obliquely notched before the tip of the first vein. Legs black.

Length 4.5 mm.

Described from 9 males taken by the writer on Mount Lowe, California, near the upper end of the electric car line, on July 3, 1917.

Type.—Male, Cat. No. 27242, U.S.N.M.

Family CHLOROPIDAE

Genus CHLOROPS Meigen

Chlorops Meigen, Illiger's Magazine, vol. 2, p. 278, 1803.

CHLOROPS KUWANAE, new species

Male and female.—General color light yellow, thorax with three broad, opaque, black stripes, the inner much abbreviated behind, and a small black stripe above each wing. Front about half as wide as head, dull yellow with only small and scattered hairs; frontal triangle shining, the sides convex, apex drawn out in a long point which reaches the lunule; a roundish black spot covers all the triangle except the point and the basal angles, the latter yellow to the ocelli; antennae of ordinary size, first joint yellow, second brown, third black, with a very blunt upper angle, arista white with yellow basal joint. Face light yellow, white in male, bucca of same color, one-fifth the eye height; epistoma not much projecting. Palpi, proboscis and edge of mouth pale yellow. Occiput yellow, a large black spot extending downward from the vertex, widening below. Thorax shining except the dorsal stripes, with dark hairs and very minute bristles; pleurae light yellow, with a small black spot below the anterior spiracle, an interrupted oblique brown one on the mesopleura, the lower three-fifths of sternopleura light brown, sometimes with blackish upper edge. Scutellum convex, with two pairs of small bristles. Halteres pale yellow. Abdomen wholly pale yellow except four transverse black bands at the bases of the segments, which do not quite reach the lateral margin. Legs wholly yellow except the last tarsal joint of the middle and hind ones, and the last two joints of the front ones, which are brown. Wings hyaline; crossveins separated by a distance equal to two-thirds of the last segment of the fifth vein; third and fourth veins hardly divergent;

the costal segment before the second vein nearly one and one-half times the following one.

Length 2.6 mm.

One male, six females, Nishigahara, Tokyo, Japan, from larvae boring in rice stems; one vial of affected stems in alcohol, and two puparia dry in vial. Two females will be returned to Professor Kuwana from the type lot.

Type.—Male, Cat. No. 23927, U.S.N.M.

Family TRYPETIDAE

Genus ANASTREPHA Schiner

Anastrepha Schiner, Novara Reise, 1868, p. 263.

ANASTREPHA SCHAUSI, new species

Male.—A reddish-yellow species with wing pattern of *parallela*, but the mouth strikingly ornamented.

Head yellow, third antennal joint blackened on apical third, palpi yellow; the whole edge of mouth swollen and expanded, with a narrow shining black line on the prominent part; above this line on the sides the color is contrasting white, but across the face the black line is less sharply defined and above it the color is yellow like the rest of the face.

Thorax yellow, a white pruinose stripe on middle of mesonotum, wider behind, and a narrow whitish stripe above root of wing. Pleura yellow, whitish along the suture above. Metanotum and halteres yellow.

Abdomen yellow, unmarked, the fifth segment darker and more shining, and almost equal in length to the third and fourth combined. Legs yellow, the larger bristles brown.

Wings with the clear area including the second basal cell continued distally and forward to the costa without interruption; the inverted V-shaped hyaline area beyond this is not interrupted, though somewhat narrowed, at the third vein. Thus there are three separated areas of brown and yellow coloration, almost exactly as in Loew's figure of *parallella.*[1]

Length, 10.6 mm.

One male, Juan Vinas, Costa Rica, January 11, collected by William Schaus and J. T. Barnes, and named in honor of the former, the distinguished lepidopterist.

Type.—Male, Cat. No. 26837, U.S.N.M.

ANASTREPHA BARNESI, new species

Female.—A yellow species with wing pattern like *parallela*, fourth vein more strongly curved forward than usual, and exceptionally long ovipositor.

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[1] Mon. N. Amer. Dipt., vol. 3, 1873, pl. 11, fig. 20.

Head yellow, including proboscis, palpi, and antennae. Thorax yellow, mesonotum without median stripe, but with one above root of wing ending at suture, and one on mesopleura just below notopleural suture; the double inflated sclerite between halter and root of wing is white on the mesial portion; otherwise the whole thorax is yellow. Halteres yellow in one specimen, the knob infuscated in the other. Abdomen short and wide, wholly yellow; ovipositor as long as all the rest of the insect, the parts measuring by micrometer as follows: Head, 18; thorax, 50; abdomen, 35 (total, 103); ovipositor, 103; the ovipositor is darker brown than the body, covered with dark hair, the basal third tapers gradually while the remainder is cylindrical. Legs yellow.

Wings with yellow and brown pattern as in *parallela*, but the fourth vein curves so far forward that the first posterior cell is more nearly closed than usual (by micrometer 7 units wide at tip and 12 units a little before).

Length with ovipositor, 19 mm.; without, 9.5 mm.

Two females, Cayuga, Guatemala (Schaus and Barnes).

Type.—Female, Cat. No. 26838, U.S.N.M.

Named in honor of J. T. Barnes, the companion of William Schaus, and discoverer of this species.

ANASTREPHA CORDATA, new species

Female.—A black-marked species with long ovipositor and striking heavy blackish spot covering hind cross vein.

Head yellow, the ocellar triangle, orbits at vertex and an indefinite occipital spot shining black: antennae yellow, palpi narrowly infuscated at tip. Thorax yellow, the dorsum with a pair of inner black stripes abbreviated behind, and an outer pair interrupted at the suture and abbreviated in front; a transverse black band just in front of scutellum; pleurae yellow, metanotum with a heart-shaped, shining black spot, notched with yellow in the middle above. Halteres yellow.

Abdomen yellow, the second to fifth segments with successively narrower basal black bands, that on the fifth interrupted. By micrometer the measurements are as follows: Head 16; thorax 34; abdomen 30 (total 80); ovipositor 49. Thus the ovipositor is about five-eighths as long as all the rest of the insect. It is yellow, more brown apically, tapering on the basal half, and densely hairy.

Wing with the pattern of uniform clear yellow color except the inverted **V**, of which one arm covers the posterior cross vein; this **V** is all blackish in color, and the part covering the cross vein is expanded and very striking. The hyaline stripe extending from the second basal cell to the costa is interrupted at the third vein

while the tip of the inverted V is also connected on its basal side along the third vein with the yellow of the middle band. The fourth vein curves forward at tip only a very little.

Length with ovipositor 11.5 mm.; without, 6.75 mm.

One female, Belize, British Honduras, collector unknown. From the writer's collection, now a part of the United States National Museum.

Type.—Female, Cat. No. 26839, U.S.N.M.

ANASTREPHA OBSCURA, new species

Male.—Head, thorax and abdomen yellow, a black spot in ocellar triangle and one just behind the root of the wing on the outer end of the postalar declivity. Mesonotum more reddish-yellow with pale yellow scutellum, and five more or less distinct pale longitudinal stripes, the outer including the humeri and notopleural suture. Upper edge of sternopleura and sides of mesonotum also pale.

Front with two orbitals turned back. Thoracic chaetotaxy as in *serpentina* Wiedemann. Abdomen unicolorous, the fifth segment not much longer than the fourth. Legs yellow, including the tarsi.

Wings of very characteristic color, the usual undulating bands obscured by a general brown infuscation, which leaves as subhyaline or distinctly lighter only a triangular spot on the costa beyond the first vein, the anal angle and two triangles on the hind margin, occupying a part of the second and third posterior cells. On examination with a lens there is a rather distinct division in color between the yellow-brown typical pattern and the plain brown obscuration: the outer border of the former crosses the discal cell diagonally beyond the anterior cross vein, continuing straight on to the third vein and thence along it to the costa, receiving on the way a narrow streak from behind which in its posterior part incloses the hind cross vein. The stigma and the base of the first basal cell and some indefinite expansions from the latter are deeper brown as well as the base of the third posterior cell. The fourth vein curves forward at tip as usual, and the first and third veins are setulose.

Female.—The ovipositor (sixth apparent segment) is about twice as long as the rest of the abdomen, cylindrical or slightly tapering, reddish in color.

Length of male, 8.5 to 10 mm.; of female, over all, 13.5 to 14.5 mm.; of ovipositor, 5 to 5.8 mm.

Described from four males and four females, from Trinidad, West Indies. Three were reared at Maraval, Trinidad, from larvae in *Lucuma multiflora*, the tropical fruit called jacana, by W. Büthn. One pair are deposited in the British Museum.

Type.—Female, Cat. No. 27246, U.S.N.M.

ANASTREPHA ORNATA, new species

Female. Head yellow, the third antennal joint twice the second, bordered with brown on front edge; palpi also tinged with brown at tip; upper two frontals turned backward; back of head with a blackish spot on each side of the occiput.

Thorax black with the following parts bright yellow: humeri; a narrow median stripe widening suddenly just before the prescutellars where it ends; a lateral stripe above the root of the wing, extending forward to the suture and inward a short distance on this; all the scutellum except a basal border above; a stripe on upper mesopleura and a space below the root of the wing including most of the hypopleura and the side of the metanotum; propleura and region about front coxae; and a stripe on the upper edge of the sternopleura once interrupted. There is also a reddish rather square spot on the middle of the dorsum, divided by the median stripe; and the sternopleurae are red along the median line.

Abdomen blackish with wide hind borders of the segments yellow; sixth segment (ovipositor) much longer than preceding part of abdomen, round, brown, hairy. Legs entirely yellow.

Wings hyaline with yellow and dark-brown pattern much like that of *serpentina*, but very distinct. The base of the costa has a blackish stripe ending at the tip of the first vein. A second blackish stripe begins at the base of the main stem-vein, fills the first basal to beyond the end of the second basal, then tapers off on the third vein and ends some distance before the anterior cross vein; the space between this and the costal stripe is largely filled with yellow. A third stripe begins narrowly at the outer hind corner of the second basal, follows the fifth vein (bulging behind it) more than halfway to hind cross vein, then becoming narrower runs straight in a diagonal direction to the costa, including the anterior cross vein (which is itself decidedly oblique to correspond); at the costa it widens again and runs to the apex of the wing, its widest part being where it includes the tip of the third vein. A fourth black stripe includes the anal cell, follows the anal vein to the margin, follows the margin to the posterior cross vein, then includes the latter and ends narrowly just in front of the fourth vein, without any trace of an arm turning back to the hind border. The basal half of the discal cell is faintly tinged with yellow; disregarding this we may consider that the hyaline portion is continuous from the second basal to the costa. The oblique position of the anterior cross vein is a striking character.

Male.—Only the first and second abdominal segments have black basal border, the others are wholly yellow.

Length of female, without ovipositor, 6 mm; with ovipositor 9 mm.

Length of male 6.5 mm.

Described from one female and two males, collected by F. X. Williams at Banos, Oriente, Ecuador, altitude 6,000 feet. One of each sex was captured on October 30, 1922; the other specimen was taken "On Luma Tree," January 19, 1923. Received from the Hawaiian Sugar Planters' Experiment Station.

Type.—Female, Cat. No. 27130, U.S.N.M.

PHOBEMA, new genus

Wing like *Anastrepha;* ovipositor like *Toxotrypana;* face with distinct antennal grooves, separated by a broad, rounded carina, which becomes more prominent upward, projecting in a rounded knob between the antennae at their base, widely separating them. The front is wide and flat and protuberant, making approximately a right angle with the face; there are two upper frontals turned back, the postverticals are present, the ocellars present but very small. Thoracic chaetotaxy: posterior dorcentral 1, far back; humeral 1; notopleural 2; presutural 1; supraalar 1; postalar 2; mesopleural 1 near upper hind edge; scutellar 2 pairs.

The relationship is with *Anastrepha*, from which the greatly elongated ovipositor would not separate it; but the facial structure is very different.

Type of the genus.—Phobema atrox, new species.

PHOBEMA ATROX, new species

Female.—General color brown tending toward yellow. Head dark yellow, the carina shining and translucent, the antennal grooves with whitish pollen; antennae dark yellow, reaching a little over halfway to the epistoma; third joint hardly twice the second, arista thin and bare. Palpi rather large and flat, yellow; probocis short, fleshy. Bucca (below eye) hardly one-third eye height. Back of head somewhat translucent.

Thorax dark yellow, scutellum triangular, short, halteres with brown knobs. Abdomen brown; first and second tergites united without suture, their sternites however distinct; sixth tergite very short, with a row of black hairs behind; seventh abdominal segment (ovipositor) longer than the whole of the rest of the fly, round in cross section, dark and curved upward at base, thence nearly straight and yellow, the extreme tip blackish.

Wing large and long, hyaline with yellow pattern as in *Anastrepha pseudoparallela* as figured by Loew.[2] Fourth vein distinctly curved forward just before reaching the margin as in the genus *Anastrepha.*

Male.—Front not quite so protuberant; abdomen clavate, lateral borders of tergites 3—5 with large hairs slanting backward.

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[2] Mon. N. A. Diptera, vol. 3, pl. 11, fig. 24.

Length of female without ovipositor 12 mm; with ovipositor 28 mm. Length of male 12 mm.

Described from two females and one male, collected by F. X. Williams at Banos, Oriente, Ecuador, January 19, 1923, "On Luma Tree." Received from The Hawaiian Sugar Planters' Experiment Station.

Type.—Female, Cat. No. 27129, U.S.N.M.

Family SAPROMYZIDAE

Genus LONCHAEA Fallén

Lonchea FALLÉN, Ortalides, p. 25, 1820.—BECKER, Berl. Ent. Zeitsch., vol. 40, p. 322, 1895.—MELANDER, Psyche, vol. 20, p. 61, 1913.—BEZZI, Bull. Ent. Research, vol. 9, p. 250, 1918; vol. 11, p. 199, 1920.

LONCHAEA HIRTITHORAX, new species

Male.—Shining black. Wings and two basal joints of tarsi yellow. Front velvet black, clothed with numerous long hairs, which are mostly in four rows; width of the front above the antennae about one-seventh of the headwidth; third antenal joint slightly elongated, about one-half longer than wide, hardly reaching epistoma. Parafacial with very slight gray pruinosity, hardly visible except in favorable light. Palpi black, rather broad; epistoma at the sides with numerous large hairs, many of which are upturned; lunule bare. Thorax shining, covered with long, erect hair, among which no distinct acrostichals or dorsocentrals are visible except close to the scutellum where there appear to be two pairs of each. Scutellum shining black with two pairs of longer bristles and a marginal row of hairs between them. Pleurae shining, the mesopleura with abundant long hairs largely curved forward and upward, those along the hind margin bristlelike. Upper edge of sternopleura with a cluster of upturned large hairs. Halteres entirely black. Calypters black with fringe of same color. Abdomen wholly shining with rather abundant long hairs especially along the sides. Wings yellow, more infuscated apically and at the extreme base; the small crossvein is opposite the tip of the first vein. Legs shining black except the tarsi, of which the first joints are yellow, the remainder brownish or black.

Female.—Front somewhat wider than in the male, with shorter hairs; the hairs of the epistoma, mesonotum and abdomen also noticeably shorter than in the male. Two distinct pairs of dorsocentrals with some hairlike ones anterior to them.

Length. Male, 4 mm., female, 3.6 mm.

Described from 14 specimens reared at Forest Grove, Oregon, by L. P. Rockwood, from *Lupinus polyphyllus*.

Type.—Male, Cat. No. 27243, U.S.N.M.

The nearest related form is *Lonchaea aberrans* Malloch, which is much less hairy, has a narrower front and the third antennal joint almost circular.

Mr. Rockwood writes that the larvae of this species are found in the stems of the plant just above the ground, often in such numbers that the plants are weakened and fall over by their own weight.

Family MUSCIDAE

Genus MESEMBRINA Meigen

Mesembrina Meigen, Syst. Beschr., vol. 5, p. 10, 1826.

MESEMBRINA MAGNIFICA, new species

Female.—Black, the parafacials golden pollinose to the edge of the mouth, sharply dividing behind from the shining black bucca; width of front 0.30 of the headwidth, much less than in *meridiana*, *mystacea*, etc. Antennae slender, the arista yellow nearly to tip, plumose; palpi black. Thorax entirely black, the humeri and a median dorsal stripe reaching the transverse suture are pale yellow, pollinose. The dorsum has only small black hair and a few bristles which are very delicate except those at the margins and behind. Posterior dorsocentrals 2; anterior 1, hairlike, just before the suture. Posterior acrostichals 1; anterior none; humeral 3; posthumeral 1, very slender; prescutellar 1; notopleural 3 (the usual hind one doubled on both sides); supraalar 4 or 5 (only one large); postalar 2 (postalar declivity bare); sternopleural 2. Calypters deep orange. Abdomen black, first and second segments with black hair, except some reddish at base of first. Third segment covered with golden pile, its ground color tending toward reddish. Fourth segment with longer and more erect golden pile, its ground color distinctly red. Legs black. Wings deep yellow at base, infuscated toward the tip and anal angle. Venation as in *mystacea*, except that the opening of the first posterior cell is before the extreme apex of the wing.

Length 18 mm.

Described from one female specimen in excellent condition, collected at Suifu, Szechuen, China, by D. C. Graham.

Type.—Female, Cat. No. 27244, U.S.N.M.

BALIOGLUTUM, new genus

Hypopleural bristles wanting; fourth vein curved forward, the apical cell at tip slightly more than half as wide as at its widest part; third vein with a few distinct hairs below, none above; stem of venation not (as in *Chrysomyia*, etc.) ciliated behind; facial

plate with a low but very sharp keel, beginning at the top, lower part of the plate strongly narrowed by the ridges, the vibrissae twice the length of the second antennal joint above the mouth; facial ridges swollen below and convergent, covered with several rows of short, spiny hairs, which extend upward in one or two rows almost to the level of the arista; palpi rather short, flat; proboscis very short, with fleshy labella, front of male above about one-seventh the head-width, ocellar bristles, verticals, and upper frontals reduced to hairs, the lower frontals gradually larger, ending at insertion of antennae; parafrontals hairy down to same point. Lower part of head without bristles except about three pairs below vibrissae. Third antennal joint three to four times as long as second; arista with a few rays of moderate length above near base, and one or two below. Eyes bare.

Thorax nearly bare of bristles above, of the dorsocentrals only the hindmost are distinct; scutellum without discal bristles; postscutellum not developed; prosternum, pteropleura, and hypopleura bare; sternopleura with a single bristle in the anterior upper corner and a considerable row of mixed bristles and long hairs along the upper edge posteriorly. Abdomen entirely destitute of bristles; first sternite hairy, 2 to 5 broad and hairy; genitalia small. Calypters large, bare, the hind ones much larger and longer than the others. Hind tibia without calcar.

BALIOGLUTUM ILLINGWORTHI, new species

Male.—Front 0.14 of the head-width at vertex, very gradually widening below; parafrontals and parafacials golden pollinose, a changeable dark spot at the level of the antennal insertion; parafacials without hairs, shining; antennae reddish, the third joint infuscated at tip and on upper side; palpi reddish-yellow; bucca one-fourth the height of head. Mesonotum, scutellum, and abdomen dotted all over with minute darker spots on a dense gray pollinose ground, the mesonotum showing four rather distinct darker stripes in front, abdomen not at all tessellated, scutellum with shining black border. Pleurae subshining black. Chaetotaxy: Dorsocentrals 0,1 (and a few hairs in the row); acrostichals 0,1 (an indistinct smaller pair close to the prescutellars); humeral 3; posthumeral 1; presutural 1; supraalar 3; intraalar 1 (behind); postalar 2 or 3; scutellum with 4 marginal, 2 submarginal, no discal; prothoracic a strong tuft. Calypters white. Wings glassy hyaline, veins brown. Legs black, with few bristles except the front femora, which have the usual two rows above and one on lower hind side. Hind tibia with short cilia on outer hind side.

Female.—Front at vertex 0.24 of head-width; no orbital nor cruciate bristles.

Length 8.4 to 10.4 mm.

Three males, one female, Cairns, North Queensland, Australia, collected by A. P. Dodd and J. F. Illingworth. Two males are returned to Dr. Illingworth, after whom I name the species.

Type.—Male, Cat. No. 26840, U.S.N.M.

Family CALLIPHORIDAE

Genus MESEMBRINELLA

Mesembrinella GIGLIO-TOS, Bull. Mus. Zool. ed Anat. Comp. R. Univ., Torino, vol. 7, No. 132, 1892, p. 4; Mem. R. Acad. Sci., Torino, ser. 2. vol. 45, 1895, p. 11.—ALDRICH, Proc. U. S. Nat. Mus., vol. 62, art. 11, 1922, p. 8.

An interesting character of the genus not previously mentioned is the existence of a post-scutellum, the absence of which has been considered a family character in Calliphoridae and Sarcophagidae. As here developed, however, it is much less bulging than in Dexidae and Tachinidae.

The discovery of four new species in collections submitted for identification by Prof. A. L. Melander makes a new analytical table of the genus desirable. For convenience it is put in the same form as the one previously published by me.

ANALYTICAL TABLE OF THE GENUS MESEMBRINELLA

A^1. Stem-vein bare (subgenus **Mesembrinella**).

a^1. Two presutural bristles present.

b^1. Legs almost black, but middle and hind femora yellow on apical half.

c^1. Wing with heavy subcostal black stripe not reaching the third vein, the posterior portion paler; 3 posterior acrostichals (Bolivia Surinam) ---------- **brunnipes** Surcouf.

c^2. Wings deep brown, the second fourth except behind yellow (Bolivia). **pictipennis** Aldrich.

b^2. Femora and tibiae yellow.

c^1. Apical cell very wide open, the included costal section more than half as long as the preceding one (Costa Rica, Ecuador). **umbrosa** Aldrich.

c^2. Apical cell less widely open, the included costal section less than half the preceding one.

d^1. Wing with only diffuse and not very strong infuscation (widespread neotropical) ---------- **bicolor** Fabricius.

d^2. Wing with heavy blackish subcostal stripe, beyond middle, before third vein (Brazil) ---------- **batesi** Aldrich.

a^2. Only one presutural present.

b^1. Fourth abdominal segment with a discal row of bristles.

c^1. Femora, pleurae, and abdomen bluegreen or blackish; 2 pairs acrostichals before suture.

d^1. Discal scutellar bristles small, almost in line with the much larger basal lateral pair; female with but one pair of proclinate orbitals, which are almost in the frontal row (Costa Rica). **uniseta**, new species.

d^2. Discal scutellar bristles but little smaller than the lateral basal pair, and forming with them a strong curve; female with two pairs of orbitals, just outside the frontal row, which is here very hairlike (Peru) ---------- **cruciata** Townsend.

c^2. Femora, pleurae, and base of abdomen yellow.

d^1. One pair anterior acrostichals.

e^1. Posthumeral 1 (Panama) ---------- **tibialis** Aldrich.

e^2. Posthumeral 2 (South America) ---------- **aeneiventris** Wiedmann.

d^2. No anterior acrostichals.

e^1. Mesonotum viewed from behind shows three dark stripes, separating four pollinose ones (Brazil) ---------- **purpurata** Aldrich.

e^2. Viewed from behind the pollen is not distinctly divided into 4 stripes (Costa Rica) ---------- **semiflava**, new species.

b^2. Fourth abdominal segment without discals.

c^1. Facial ridges high and sharp, hairy to middle; middle and hind tibiae not at all infuscated; sternopleurals 2, 1 ---------- **facialis** Aldrich.

c^2. Facial ridges lower, not hairy except close to vibrissae.

d^1. With 1 or 2 pairs of anterior acrostichals.

e^1. Legs, pleurae, and base of abdomen largely yellow.

f^1. Second to fourth abdominal segments with a posterior sharply defined violet band; third segment without marginal bristles (Brazil) ---------- **cyaneicincta** Surcouf.

f^2. Second to fourth abdominal segments not banded with violet; third segment with row of marginals (Costa Rica).
flavicrura, new species.

e^2. Legs, thorax, and abdomen bluegreen or blackish; fifth sternite of male produced in two shining black styles (Costa Rica).
spicata, new species.

d^2. Without anterior acrostichals.

e^1. Only one intra-alar (the posterior); abdominal segments 2–4 with sharply defined posterior violet bands (Brazil).
pauciseta Aldrich.

e^2. With 2 intra-alars; abdomen not violet-banded.

f^1. Second abdominal segment with only weak hairs along hind margin (South America) ---------- **randa** Walker.

f^2. Second abdominal segment with a distinct row of marginal bristles.

g^1. Middle and hind tibiae black, in male the middle ones elongated and with only minute bristles (South America).
quadrilineata Fabricus.

g^2. Middle and hind tibiae not or hardly infuscated; male with the usual bristles on middle tibiae (Brazil).
dorsimacula Aldrich.

A^2 Stem-vein ciliated behind (subgenus **Mesembolia** Aldrich).

a^1. Greatest width of apical cell exceeding the length of the hind crossvein.

b^1. Apical cell moderately wide open, the included costal segment not more than half the preceding one; no acrostichals immediately behind the suture (Mexico to Paraguay) ---------- **bellardiana** Aldrich.

b^2. Apical cell very wide open, the included costal segment more than half the preceding (Brazil) ---------- **fulvipes** Aldrich.

a^2. Greatest width of apical cell less than hind crossvein (Brazil).
peregrina Aldrich.

MESEMBRINELLA SPICATA, new species

Male.—Purplish-black in color, only the palpi, face, antennae and lower part of front bright yellow. Front wide for a male, 0.115 of the head width by micrometer (one specimen), the frontal rows composed of delicate hairs to the middle, below about 7 larger, the lowest just below antennal insertion; ocellars large, proclinate, a pair almost as large behind the triangle; vertical only one pair. Third antennal joint more than three times the second: facial ridges rather high and sharp, hairy almost to the middle of the third antennal joint; bucca one-fifth the eye height.

Mesonotum not with distinct pollinose stripes. Chaetotaxy: dorsocentral 2, 3; acrostichal 2, 1; humeral 3; posthumeral 2; presutural 1; notopleural 2; supraalar 3; intraalar 2; postalar 3; scutellar 2 lateral, 1 large apical, 1 large discal; sternopleural 2. Pleurae concolorous with mesonotum. Calypters transparent with black rim and conspicuous black fringe. Both thoracic spiracles large, dark.

Abdomen purplish-black, with rather dense, erect, short hair, no bristles whatever. Genital segments large and conspicuous, shining black; inner forceps shining black, parallel and close together, not tapering, blunt at tip, the base behind united and swollen into a sudden hump which is paler in color, divided into two arms backward toward the anus, and these arms bear a pair of black, converging processes ending in tufts of black hair which touch each other on the middle line. Outer forceps shining black, twisted, blunt. Fifth sternite narrow, shining black including its sides, with two erect, blunt, shining black processes in the place of the usual lobes.

Legs blackish; middle tibia with flexor bristle; hind tibia with long calcar just below middle.

Wings subhyaline, small cross vein infuscated; the opening of the apical cell at costa is about one-fifth the preceding costal segment.

Length 8.3 mm.

Described from one male, La Suiza de Turrialba, Costa Rica, February 22, 1923 (Pablo Schild). Through the kindness of Prof. A. L. Melander we retain this striking unique for the United State National Collection.

Type.—Male, Cat. No. 26796, U.S.N.M.

MESEMBRINELLA UNISETA, new species

A blue-black species with face, antennae, palpi, and thoracic spiracles yellow.

Male.—Front rather wide, 0.13 the head width (the same in three specimens measured by micrometer), black to antennae; no frontals of any size above the middle; ocellars long, proclinate, a post-ocellar pair also long; only one moderate pair of verticals. Third antennal

joint two and one-half times the second; arista with long but sparse plumosity; facial ridges flat, only a few hairs above vibrissae; bucca yellow, about one-ninth the eye height.

Mesonotum blue-black, with white pollen visible more from behind, not distinctly striped. Chaetotaxy: dorsocentral 2, 3; acrostichal 2. 1; humeral 3; posthumeral 2; presutural 1; notopleural 2; supra-alar 3; intraalar 2; postalar 3; scutellum with 1 lateral; 1 apical, 1 rather small discal: sternopleural 2, 1. Calypters rather dark, the anterior with black rim. Spiracles large, yellow.

Abdomen blue-black, with a little white pollen visible in certain directions, not tessellated; first segment with one large lateral marginal; second with two laterals and sometimes a median marginal pair (2½ times in five males); third segment with strong marginal row of 10; fourth segment with distinct discal row of 4 to 6 (usually not continuing down the sides), and an apical row of 6 to 8. Genital segments rather large, shining black, with hair but no bristles. Inner forceps black, flat and broad at base, but tapering to a slender, sharp tip; outer forceps black, narrowed at base, broader in middle, with sharp tip. Fifth sternite with ordinary deep incision in middle and two large, black, subshining, flat lobes.

Legs black, middle tibia with flexor bristle, hind tibia with large calcar below middle.

Wings lightly infuscated, hind crossvein deeply so; fourth vein beyond hind crossvein bowed a little backward so as to widen the apical cell, which includes at its tip a costal segment about one-seventh of the preceding.

Female.—Front of equal width almost to antennae, 0.25 the head width (average of three, 0.24, 0.25, 0.27), the middle stripe red over halfway up.

Length 8 to 8.5 mm. in both sexes.

Described from 6 males and 4 females, La Suiza de Turrialba, Costa Rica, February 22 to March 29, 1923, and September 5 and October 1, 1921. In Prof. L. Melander's collection.

Paratypes.—Male and female, Cat. No. 26797, U.S.N.M.

MESEMBRINELLA SEMIFLAVA, new species

Male.—Front almost as wide as the narrow ocellar triangle, the narrow parafrontals touching for some distance; frontal bristles beginning about the middle; ocellars long, proclinate, the post-ocellar pair about half as long; one pair of smallish verticals. The head is yellow except upper two-thirds of back and upper third of front; antennae and palpi yellow; third antennal joint not much more than twice the second which is a litle longer than in some species; arista long, with long but sparse plumosity; facial ridges

rather flat, only a few hairs above vibrissae; bucca very narrow, hardly one-eighth the eye height.

Mesonotum, except humeri, metallic blue-green, overlaid with some white pollen, especially anteriorly; the two outer of the usual dark stripes are rather distinct, the inner not so. Chaetotaxy: dorsocentrals 2, 3; acrostichals 0, 1; humeral 2; posthumeral 1; presutural 1; notopleural 2; supraalar 2 and a small behind; intrallar 2; postalar 2 (the front one small); scutellum with one lateral, 1 apical, 1 discal; sternopleural 2, and a small hairlike one below the posterior. Pleurae and humeri yellow. Calypters lightly infuscated, the front one with black rim. Thoracic spiracles large, yellow.

Abdomen pale yellow at base, blue and violet at tip. The first segment is yellow with a blackish narrow line at hind edge, extending below; the second segment is yellow with a purplish hind border, wider at middle, where it is nearly half the segment and very narrow below; third segment yellow anteriorly at side and more below, the rest blue, but the hind border purple; fourth segment blue above and below with a distinct white pollinose spot each side of the genitalia and hardly a trace of purple apically. The first segment has several lateral bristles. the second one, the third a strong marginal row, the fourth a discal row of 8 and a smaller marginal row. Genital segments of moderate size, brownish or piceous, shining, with hairs but no bristles. Inner forceps yellow, slender, nearly straight, with sharp black tips; outer forceps yellow, slender, strongly bowed in at tip. Fifth sternite small yellowish, cleft in middle.

Legs yellow, middle and hind tibiae and tips of their femora black; hind tarsi lighter than their tibiae; middle tibia without flexor bristle, hind tibia with long calcar a little below middle.

Wings long and narrow, infuscated, more distinctly beyond tip of auxiliary vein, but with no definite pattern; apical cell opening on costa just before apex for a distance equal to one-seventh the preceding costal segment.

Female.—The front is narrowest at vertex, where it is 0.18 of the head-width in both specimens; cruciate bristles distinct, only 3 to 4 lower frontals of any size; orbitals represented only feebly by hairs but the lower pair in one specimen a trifle stouter. Abdomen with much less yellow, none above on the third segment, and a wider dark margin on the second.

Length of male, 8.5 to 9 mm.; of female, the same.

Described from three males and two females, La Suiza de Turrialba, Costa Rica, February 23–28 and March 16, 1923 (Pablo Schild). In Prof. P. L. Melander's collection.

Paratypes.—Male and female, Cat. No. 26799, U.S.N.M.

MESEMBRINELLA FLAVICRURA, new species

Blue-black, the following parts yellow: Front except upper half or less, antennae, face, bucca, palpi, humeri and lower prothoracic region, thoracic spiracles, first abdominal segment in large part in the male (less in the female), coxae, all the femora except the tips.

Male.—Eyes almost contiguous, the front at narrowest only as wide as the anterior ocellus; the rows of frontal bristles begin below the narrow part; ocellars and post-ocellars of equal size, not large; verticals small. Facial ridges quite flat, only a few hairs above vibrissae; bucca one-fifth the eye height.

Thorax not with distinct pollinose stripes. Chetotaxy: dorso central 2, 3; acrostichal 2, 1; humeral 3; posthumeral 2; presutural 1; notopleural 2; supraalar 3; intraalar 2; postalar 3; scutellum with 2 lateral, 1 apical, 1 discal. Calypters infuscated, especially the posterior, with dark rims. Spiracles large, yellow.

Abdomen bluish-purple, the first segment yellow except a narrow black posterior border above and below which widens suddenly at the sides; second segment with trace of yellow above anteriorly. The first segment has one small lateral marginal, the second a large one, the third and fourth a marginal row, no discals. One male has a small but unmistakable pair of median marginals on the second segment.

Legs black except as indicated, middle tibia with flexor bristle, hind tibia with large calcar below middle.

Wings lightly infuscated, paler toward base; small cross vein decidedly infuscated; fourth vein and apical cell as in *uniseta.*

Female.—Front 0.23 of headwidth (average of three, 0.22, 0.24, 0.24); two pairs of orbitals; only one vertical. First abdominal segment varying in amount of yellow, sometimes with much less than indicated for male.

Length of males, 7 and 7.8 mm.; of females, 8 to 8.5 mm.

Described from two males and five females, La Suiza de Turrialba, Costa Rica, February 8 to July 26, 1923 (Pablo Schild). In Prof. A. L. Melander's collection.

Paratypes.—Male and female, Cat. No. 26800, U.S.N.M.

Tribe CHRYSOMYIINI

TABLE OF GENERA OF THE WORLD

1. Hind calypters covered with hairs on upper side (Eastern Hemisphere except *Chrysomyia desvoidyi* Hough, noted below) ---------------- 2
   Hind calypters bare except in the basal depression (Western Hemisphere) ---------------- 3
2. Vibrissae at least the length of the second antennal joint above oral margin (type, *marginalis* Fabricius) ----- **Chrysomyia** Robineau Desvoidy.
   Vibrissae at oral margin; male with broad front; small Australian species (type, *varipes* Macquart) ---------------- **Microcalliphora** Townsend.

3. Palpi slender and very short; vibrissae at least the length of the second antennal joint above the oral margin and distinctly approximated; dorsocentrals only one or two pairs just before the scutellum (type, *macellaria* Fabricius) mesonotum striped__________**Cochliomyia** Townsend.
   Palpi normal, clavate____ 4
4. Vibrissae at oral margin, hardly approximated; dorsocentrals 2, 4, small but distinct (type, *segmentaria* Fabricius) mesonotum not striped.
   Hemilucilia Brauer.
   Vibrissae at least the length of the second antennal joint above the oral margin ____ 5
5. Without dorsocentrals except one or two pairs next to the scutellum; mesonotum striped (type, *fulvipes* Macquart; *Compsomyiops* Townsend, same type)______________________**Paralucilia** Brauer and Bergenstamm.
   Dorsocentrals 2, 4, small but distinct (type, *semiviridis* Van der Wulp) mesonotum not striped_____________________**Chloroprocta** Van der Wulp.

Neopollenia Brauer, *Neocalliphora* Brauer and Bergenstamm, and *Paracalliphora* Townsend, all from the oriental and Australian regions, which were placed in *Chrysomyiini* in the National Museum collection by Townsend, have bare stem vein and I would refer them to the tribe *Calliphorini*, with which head structure also agrees.

Malloch in a recent paper [3] has gone still further in this direction, expressing the opinion that these three genera are at most only subgenera of *Calliphora*.

Genus COCHLIOMYIA Townsend

Cochliomyia Townsend, Journ. Wash. Acad. Sci., vol. 5, 1915, p. 646.—Shannon, Insecutor Ins. Menst., vol. 11, 1923, p. 106.

?*Callitroga* "Schiner MS" Brauer, Denkschriften Kais. Akad., vol. 47, 1883, p. 74.—Johnson, Bull. Amer. Mus. Nat. Hist., vol. 41, 1919, p. 439.

Townsend considered that Schiner's manuscript name, being "cited in synonymy," had no standing. Johnson asserted that "Brauer and Bergenstamm had a perfect right to adopt *Callitroga* Schiner MS." They did not adopt it, but they merely mentioned it in an ambiguous way as a collection name of Schiner's, apparently connecting it first and most clearly with *Lucilia hominivorax* Coquerel. This is supposed to be a synonym of *macellaria*, but may be different, and other related species are gradually coming to light. Even admitting the validity of the name for *hominivorax*, I doubt the advisability of using it as if *macellaria* were its type.

The species described below may be separated from the common and widespread North and South American *macellaria* by the following characters:

a^1. Thorax evidently metallic blue or green, with four white pollinose stripes, the inner not continued on scutellum; abdomen almost wholly shining above, or with thin and uniform pruinosity, the fourth segment with a white pollinose spot on each side widely separated__macellaria Fabricius.

[3] Trans. New Zealand Inst., vol. 55, p. 640, 1924.

9099—25——3

a^2. Thorax black with only slight traces of metallic color, the four white pollinose stripes very distinct and the inner pair continued on the scutellum; abdomen metallic green on the second and third segments with broad interrupted fascia of silvery pollen (on the third in some lights breaking up into four spots partly connected in pairs), fourth segment with a pair of silvery spots close together, elsewhere more coppery than preceding segments_______________________________laniaria Wiedemann.

COCHLIOMYIA LANIARIA (Wiedemann)

Musca laniaria WIEDEMANN, Auss. Zweifl., vol. 2, 1830, p. 406 *taniaria*, corrected, p. 683).

Campsomyia laniaria ENRIQUE LYNCH A., Anales Soc. Cient. Argentina, vol. 7, 1879, p. 256; vol. 10, 1880, p. 75 (*taniaria*, corrected, vol. 10, p. 249). Cited but not identified.

Male.—Front as wide as ocellar triangle, quite black near vertex, gradually covered with white pollen below, with numerous small white hairs which continue close to the eye as far down as the middle of the third antennal joint; bucca two-fifths the eye height, translucent yellow and shining except before and behind; back of head black to the proboscis; antennae, palpi, proboscis and facial structure as in *macellaria*, except that the vibrissae are a little nearer the epistoma. Pleurae black. Hind calypter brown on disk with white rim, a few pale hairs in the concavity close to base. Postalar declivity with tuft of long hairs on its center as in *macellaria* (above base of front calypter). Genitalia on same plan as in *macellaria* but the inner and outer forceps notably longer, and the former more slender; the penis at apex also more drawn out. Legs entirely black. Wings as in *macellaria*.

Female.—Front 0.31 of head width (average of three, 0.29, 0.30 and 0.33); parafrontals shining black above almost to middle; back of head yellow below changing abruptly to black just below neck. Fifth abdominal segment conical, polished, metallic. Otherwise as in male.

Length 5.5 to 7 mm., averaging distinctly smaller than *macellaria*.

Redescribed from one male and three females, Key West, Florida, January 31, February 1 and 6, 1869 (labels in handwriting; collector doubtful, perhaps Burgess); one female evidently collected many years ago with only the label "Fla." In addition to this old material, the United States National Museum has lately received 65 specimens of both sexes in alcohol (now pinned) from Dr. Paul Bartsch, curator of mollusks, United States National Museum, which he collected at one time on San Salvador Island, Bahamas, in the summer of 1923, on dead mollusks.

One Key West female bears the label "*Chrysomyia certima* Wlk.," in Coquillett's handwriting. This would appear from Walker's description to be a mistake, as *certima* is quite certainly a synonym

of *macellaria* (not of *Paralucilia cornicina* Fabricius, as suggested in my Catalogue, 1905, p. 516).

Wiedemann's allusion to this form by name occurs in a note following his description of *macellaria* Fabricius. Discussing the variations of the species, he says that those specimens having the white dorsal abdominal pollinose spots or interrupted cross-bands in the collection of Count Hoffmansegg were labelled *Musca laniaria*, adding that they are not otherwise materially different from *macellaria.* Although in his description, based on the Fabrician type or types and additional material of his own, he had described these fasciae as if they were typical of *macellaria*, his note seems to make it clear that *laniaria* differs from *macellaria* in possessing them.

Genus CHRYSOMYIA Robineau-Desvoidy

Chrysomyia Robineau-Desvoidy, Myiodaries, 1830, p. 444.—Townsend, Journ. Wash. Acad. Sci., vol. 5, 1915, p. 646.

CHRYSOMYIA DESVOIDYI Hough

Chrysomyia desvoidyi Hough, Kans. Univ. Quart., vol. 9, 1900, p. 203.

This was described from Brazilian specimens. As far as known it is the only American species with the hind calypter hairy, a character fortunately mentioned by Hough. It must be admitted however that the species is somewhat intermediate in this regard, since a considerable area of the lateral apical portion is bare.

Eyes of male almost contiguous for a considerable distance, separated only by the width of the front ocellars. The female has the front slightly narrowed just above the antennae, where it is about one-fourth as wide as the head (0.26 in each of two measured by micrometer). Halfway between the posterior ocelli and the eye, on the vertex of the female, there is one distinct bristle curved backward and laterally. The ocellar bristles in the female are close to the anterior ocellars and are directed straight to the side, opposite to each other. In the male, however, the ocellars are parallel and proclinate. Thorax in both sexes with much less distinct stripes than in the genera *Paralucilia* and *Cochliomyia.* In all the specimens seen the body color is deep blue-green. The hind calypter is dark brown, with white rim only in two females. The second and third abdominal segments have each a black band on the hind margin. Additional characters are given in the original description.

Six males and ten females; Quebrada Secca, Venezuela; Valera, Venezuela (Dr. C. Uribe): Cano Saddle, Canal Zone, Panama (Shannon); Erwin Island, Canal Zone, Panama (Shannon); Trinidad Rio, Panama (Busck); Las Cascadas, Canal Zone, Panama (A. H. Jennings): San Carlos, Costa Rica (Schild and Burgdorf); Cordoba, Mexico (Knab).

Genus MICROCALLIPHORA Townsend

Microcalliphora Townsend, Proc. U. S. Nat. Mus., vol. 49, 1916, p. 618.

The type species designated by Townsend was described as *Lucilia varipes* by Macquart.[4] It may be distinguished from the new species here described by the following characters. Both species are Australian.

a[1] All the femora mainly black, tibiae largely so; front in both sexes black almost to the lunule; male with dense erect white hairs on upper side of front femur, which are shorter toward apex; front femora yellow on anterior side ---------- varipes Macquart.

a[2] Male only; femora and tibiae entirely yellow; front black from vertex only as far as the upper third, then abruptly changing to pure yellow; front femur with only the usual black bristles ---------- flavifrons, new species.

MICROCALLIPHORA FLAVIFRONS, new species

Male.—Front broad, narrowest just at the level of the lunule, where it is by micrometer 0.33 in one, 0.32 in the other, of the headwidth (two males of *varipes* measure 0.33 and 0.35, and in them the front is not narrowed below). Parafrontals shining green at vertex and as far forward as the tip of the ocellar triangle, then changing suddenly to a pure light yellow, which color extends downward and covers the whole buccal region; frontal stripe a little darker yellow, wider than either parafrontal, blackish around the ocellar triangle; frontal bristles small, reaching as far as middle of second antennal joint; on the upper metallic part of the parafrontal each side are two distinct orbitals, which are reclinate and divaricate, the upper farther from the eye; two large verticals; the yellow part of the parafrontals bears small white hairs, which extend down on the parafacials as far as the middle of the third antennal joint but are almost imperceptible. Antennae yellow, the third joint broadly infuscated from the arista, five times as long as second joint. Arista rather short, the plumosity consisting of only a few long rays above and about three more appressed below; penultimate joint short. Vibrissae large and distinct, black, no black hairs above them, but the ridges rather thick and well covered with small pale hairs. Bucca one-third the eye height. Palpi yellow, clavate, of average size. Proboscis small. Mesonotum shining green, without stripes, with a very delicate pale pruinosity; dorsocentrals 3 anterior, 4 posterior; acrostichals, 1 just before suture and 1 prescutellar; sternopleurals 2; postalar declivity with several long bristly hairs in middle; lower lateral prong of scutellum (above base of calypters) bare; intraalar one large before the suture, two behind. Calypters yellowish. Abdomen bright green, first segment black and a black

[4] Dipteres Exotiques, Suppl., vol. 4, 1851, p. 222.

posterior margin on second and third segments, that on former widened in middle. Genital segments rather small, shining green. Fifth sternite as usual with deep V-shaped cleft. Legs including coxae yellow, the tarsi only becoming brown near tip. Claws and pulvilli are small.

Wings with evident brown tinge, less so posteriorly; third vein hairy almost to the crossvein. Third and fifth costal segments equal; fourth vein with short, rectangular bend near margin of wing, the apical crossvein deeply concave, ending almost in the apex.

Length, 4 mm.

Described from two males collected by Dr. J. F. Illingworth at Gordonvale, North Queensland, Australia, in 1919. One is labeled "Ex carrion."

Type.—Male, Cat. No. 26841, U.S.N.M.

Family SARCOPHAGIDAE

Genus NOTOCHAETA Aldrich

Notochaeta ALDRICH, Sarcophaga and Allies, 1916, p. 52.

Front moderately narrow in male, not protruding at antennae; parafrontals and parafacials with only a few almost imperceptible minute hairs; vibrissae at edge of mouth, not approximated; facial ridges bare except close to the vibrissae; second antennal joint short, third three times as long, almost reaching vibrissae; arista with long plumosity to tip or nearly to it; epistoma not produced, face a little receding; palpi and proboscis normal; back of head flattened.

Thorax distinctly striped, with no acrostichals except a small pair before scutellum; dorsocentrals 2 anterior, 2 or 3 posterior; presutural 1, notopleural 2, postalar declivity bare. Postscutellum not developed; calypters bare. Abdomen without discals; no median marginals on first and second segments, third and fourth with strong erect rows.

Wings as in *Sarcophaga;* first vein bare, third bristly nearly to crossvein.

The foregoing characters are taken from the type species, *subpolita* Aldrich.

KEY TO SPECIES OF NOTOCHAETA

1. With two postsutural dorsocentrals ---------------------------------- 2
   With three postsutural dorsocentrals ---------------------------------- 4
2. Facial ridges somewhat prominent, with small hairs extending above the level of the middle of the third antennal joint ----**plumigera** Van der Wulp
   Facial ridges more flattened, bare except close to vibrissae -------------- 3
3. With small but distinct prescutellars; scutellum with indistinctly defined continuation of median dark thoracic stripe; male with dense, suberect hairs on flexor surface of middle tibia ----------------**subpolita** Aldrich.

With no prescutellars; scutellum with greenish-black disk, bordered uniformly with yellow pollen; male with only appressed hair on flexor surface of middle tibia__________________________**townsendi**, new species.

4. Abdomen shining blue in color________________________**comata**, new species.

Abdomen black with golden pollinose pattern__________**angusta**, new species.

NOTOCHAETA COMATA, new species

Male.—Front 0.12 and 0.14 of the headwidth in the two specimens. Parafrontals and parafacials golden pollinose; frontal bristles about 10, the uppermost 3 pairs reclinate, the lowest of all reaching to the first third of the second antennal joint, the rows diverging only gradually; antennae black, third joint three times the second, arista long plumose not quite to tip. Palpi black, of ordinary size; proboscis short. Back of head with black hairs, only a few pale around the neck and below. Buca one-fifth the eye height.

Thorax black with green reflections; mesonotum when viewed from behind with two white pollinose stripes just inside the dorsocentral rows, and another pair from humeri to suture; behind the suture these begin again a little higher up and converge to follow the sides of the scutellum nearly to its apex. Presutural acrostichals small but distinct; sternopleurals 3, the intermediate smaller and almost in line with the others.

Abdomen subshining, blue-green, with very faint pollen except below; bristles as in generic characters; genital segments of moderate size, without bristles, but just below the anus on the inner forceps with a striking tuft of hairs. Fifth sternite with large, diverging, bare lobes, which turn up suddenly in a lobe directed forward and are truncate beyond this.

Legs black, the femora slightly bluish; middle tibia on inner hind side with suberect hair, hind tibia on inner flexor side with 2 to 3 longer, fine hairs, on outer side with one bristle.

Wings slightly smoky; third vein curved so as to widen the apical cell beyond its middle; third vein hairy almost to small cross vein.

Length, 7.5 and 8 mm.

Described from two males collected at La Suiza, Costa Rica, April 20 and 24, 1923, by Pablo Schild; they were sent to the Museum for identification by Prof. A. L. Melander. and the type is returned to him.

Paratype.—Male, Cat. No. 26842, U.S.N.M.

NOTOCHAETA TOWNSENDI, new species

Male.—Front 0.18 of the head width in each of the two specimens; parafrontals and parafacials light golden pollinose, the latter with a few just distinguishable, minute black hairs in a single row; frontals about 14, the upper 3 reclinate, the remainder rather fine

and close together reaching down to middle of second antennal joint, and only moderately diverging. Back of head with all black hairs. Head otherwise as in *comata.*

Thorax black, striped as in *comata,* but the pollinose parts are more yellowish, the scutellum is wholly bordered (seen from behind) with this color, and it extends across the prescutellar region except a brown space at middle. No prescutellar or other acrostichals; the dorsocentral usually occurring behind the suture is missing, leaving only two posterior. Sternopleurals 3. Calypters white, bare.

Abdomen decidedly bluish in ground color, bases of the segments thinly white pollinose, the pollen denser at the sides and below and diminishes gradually behind, leaving only the apical third and a median stripe on segments 2 to 4 entirely shining. No median marginals on segments 1 and 2, a strong erect row on 3 and 4. Genital segments rather large, black, with erect hair, which becomes almost bristlelike on the apex of the first. The thick broad penis is the most characteristic part. Fifth sternite with simple diverging sides, inconspicuous. Wings as in *comata.* Legs as in *comata.* but no suberect or villous hairs on the middle tibiae.

Length, 7.5 and 8.5 mm.

Described from two males collected by C. H. T. Townsend on Huascaray Ridge, Jaen Province, Peru, on September 21.

Type.—Male, Cat. No. 26843, U.S.N.M.

NOTOCHAETA ANGUSTA, new species

Male.—Blackish, the pollinose markings distinctly golden in color except on the lower part of the pleurae and legs. Head somewhat narrower in general outline than in *comata,* but the front at narrowest slightly wider; parafacials a little wider than the narrow third joint. Thorax with four golden pollinose stripes, the inner ones nearly contiguous in front; the median brownish-black stripe reaches beyond the middle of the scutellum, the two pollinose stripes on each side coalesce just in front of the scutellum; one pair of small, but distinct prescutellars; sternopleurals 2. Abdomen with a median shining blackish stripe which expands on the hind margins of the second and third segments, extending around to the venter and more or less forward on the lateral dorsal portion. No median marginals on the second segment, the third with three pairs. Genital segments black, yellow pollinose, the genitalia small, blackish. Legs black, middle tibia with one bristle on outer front side. Wings subhyaline; third vein with about six hairs at base.

Length, 7.2 mm.

One male, Corazal, Canal Zone, Panama, June, 1911 (Busck).

Type.—Male, Cat. No. 26844, U.S.N.M.

Genus SARCOPHAGA Meigen

Sarcophaga MEIGEN, Syst. Beschr., vol. 5, p. 14. 1826.

In the following three species the puparia will be described and figured in a forthcoming comprehensive work by Charles T. Greene.

SARCOPHAGA PLACIDA, new species

Fig. b.

Male.—Front 0.25 of head width (the same in both specimens); parafacials and parafrontals golden yellow pollinose, the former with only a few hairs near the eye; frontals eight, the upper one large and reclinate, the lowest at the level of the middle of the second antennal joint, hardly diverging toward the eye, about as in *communis.* Antennae black, third joint rather slender, fully twice the second, arista plumose for nearly three-fourths its length; facial ridges black below, the hairs ascending although sparsely to the middle; palpi black; bucca one-third the eye height, golden pollinose on anterior half. Beard pale except two orbital rows above, reduced to one at lower curve of eye.

Thorax gray, with three strongly marked black stripes, the inner reaching the tip of the scutellum, and a narrow, short stripe each side along the supraalars; pleura with a shining black stripe along the suture above sternopleura. No anterior acrostichals; posterior dorsocentrals four, but only the posterior two of any size; sternopleurals three; scutellum with two lateral and a subdiscal pair of bristles, and in addition to these a tuft of dense white or yellow hair on the vertical border near the base.

Abdomen tessellated as usual, toward its tip becoming reddish in ground color; first and second segments without median marginals; third with a large pair, fourth with a row of about eight. Genital segments wholly yellow, narrow and elongate; the first with only a few small hairs, the second with moderate black hair and a few small bristles. Forceps black, long and narrow and closely touching each other throughout their length, beyond the middle strongly tapering and becoming larger again near the apices, which are rounded and clavate; on the anterior side the profile is nearly straight. Accessory plate small, yellow, its anterior end bearing a tuft of black short hair. Posterior clasper small, slender, yellow, bearing a long hair near its base; anterior clasper long and flat, yellow, fitting against the penis as if a part of it, the tip truncate. Penis short, mostly black, the terminal segment consisting mostly of three structures: (*a*) A flat transverse divided posterior plate; (*b*) two slender black filaments coming up in the middle and recurved; (*c*) two lateral black rods, tapering and curving forward, connected on the anterior side with a transparent membrane which forms a half-cylinder or trough, clos-

ing the anterior side of the organ. Fifth sternite delicate, yellow, retracted, in the form of a broad U, with rather dense hair on the inner side of the arms. The inflexed ends of the fourth tergite bear long hair.

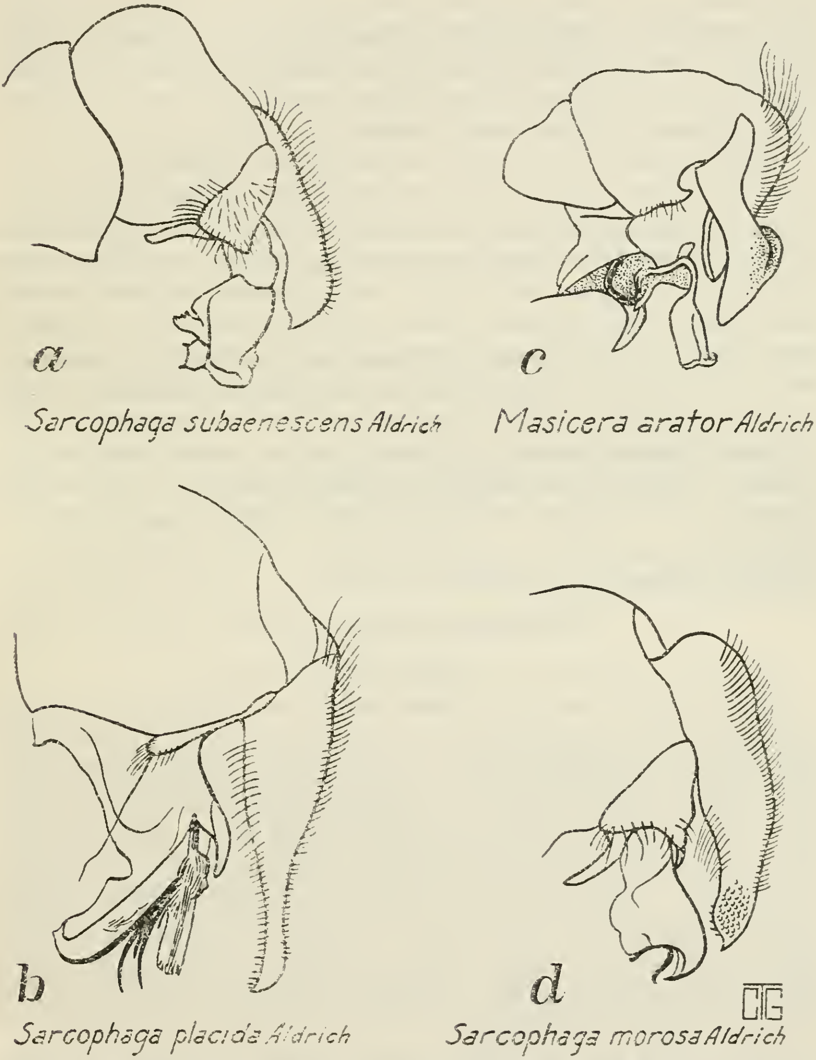

FIG. 1.—MALE GENITALIA. *a*, SARCOPHAGA SUBAENESCENS, NEW SPECIES; *b*, SARCOPHAGA PLACIDA, NEW SPECIES; *c*, MASICERA ARATOR, NEW SPECIES; *d*, SARCOPHAGA MOROSA, NEW SPECIES. DRAWN BY C. T. GREENE.

Legs black, femora stout, middle ones with comb on posterior apical edge below; middle tibia with a single bristle on outer front side; hind tibia without villosity; claws and pulvilli large, the latter infuscated.

Wings hyaline, with the usual venation; third vein with eight to ten hairs at base, reaching halfway to cross vein; third costal segment slightly longer than fifth; no costal spine. Epaulet black, subepaulet yellow.

Female.—Front 0.31 of head width (average of two, 0.30 and 0.32); the usual orbitals present, lower frontals as in male. Middle tibiae with two or three bristles on outer front side. Tufts of white or yellow hair on sides of scutellum as in male. Genital segments a little reddish, the organs much retracted.

Length of male, 10 to 11 mm.; of female, 8 to 10 mm.

Described from one male, Brownsville, Texas, collected by T. C. Barber in June, 1922; and from three lots, all from James Zetek: (*a*) One male and six females, reared at Ancon, Canal Zone, from dead Murex; (*b*) one male, one female, reared at Fort Amador, Canal Zone, from *Hylesia*, species, which we assume was dead to begin with; (*c*) four males and four females, reared at Ancon by one of Mr. Zetek's predecessors, but the data are now lost. This third lot are paler in color of pollen, and the lateral scutellar tufts are yellow instead instead of whitish, but the puparia show no differences. The type and allotype are from the lot *a*. Mr. Zetek's numbers for the three lots are Z–2305, Z–2303, and Z–1834, respectively.

Type.—Male, Cat. No. 27097, U.S.N.M.

SARCOPHAGA MOROSA, new species

Fig. d.

Male.—Front about 0.22 of head width, the head being damaged on the sides the measurement can not be taken exactly; parafrontals and parafacials pollinose with a distinct but not deep golden tinge, the former narrower than the middle stripe, the latter with a row of hairs next the eye becoming bristly below and a few additional hairs; two or three upper frontal pairs decreasingly reclinate, the uppermost not especially strong; lowest frontals strongly divergent; antennae black, third joint less than twice the second, moderately wide, arista plumose more than to middle. Palpi black; bucca about one-third eye height, with black hair except behind; back of head with mostly black hair.

Thorax with the usual three black stripes and an outer pair shorter and weaker. Acrostichals, 0, 1; dorsocentrals, 4, 3, all large; sternopleural, 3; scutellum with two lateral, one apical, and one discal near tip. Postalar declivity with hairs in the middle.

Abdomen tessellated as usual; first and second segments without median marginals, third with a pair, fourth with a marginal row. Genital segments rather large, wholly black, with erect, soft hair; forceps red on the attached basal part, the rest black, divergent, of

uniform breadth to the tip, where the hind edge curves forward to form a sharp tooth at the middle of the apex; accessory plate reddish, triangular, the apical side broad. Posterior clasper small and inconspicuous, anterior clasper long and low, rounded at tip. Penis thick and rather short, the distal segment globose, blackish; the apical posterior part is suddenly narrowed into a curved beak extending forward, underneath which two blunt filaments emerge; the side pieces of the distal segment are in the form of truncated plates, diverging apically from each other. Fifth sternite yellow, retracted, apparently a plain V.

Legs black; middle femora with combs before and behind at tip; middle tibiae with two bristles on outer front side; hind tibiae with long villosity on outer and inner flexor sides. Claws and pulvilli large, the latter infuscated.

Wings hyaline; third vein at base with four to six hairs; bend of fourth vein with stump or heavy fold; third costal segment considerably longer than fifth; no costal spine.

Length 11 mm.

Described from one male specimen, reared by F. Johansen from a larva taken near Ottawa, Canada; the fly emerged July 11, 1918.

Type.—Male, Cat. No. 27098, U.S.N.M.

The species is close to *pulla* Aldrich, but differs in the genitalia, especially the form of the accessory plate, which is entirely different, and in the forceps.

SARCOPHAGA SUBAENESCENS, new species

Fig. a.

Male.—Front 0.21 of head width (one specimen); parafrontals much narrower than median stripe, metallic above, thinly white pollinose below; frontal bristles ten, the uppermost reclinate and somewhat larger, the lowest diverging toward eye; a single vertical; ocellars normal; parafacials with thin white pollen, quite narrow below, the usual row of hairs bristly below; antennae black, third joint reddish basally, over twice the second, arista with somewhat short plumosity extending only to middle. Palpi black; bucca hardly one-third eye height, with black hair; back of head with only a little pale hair about foramen and below.

Thorax thinly glaucous pollinose, subshining, but when viewed from behind showing the usual three dark stripes well separated. Acrostichal 0,1; dorsocentral 2,3, sternopleural 3; scutellum with two lateral, one apical, and one discal; postalar declivity with a few hairs in middle.

Abdomen black with very thin tessellation, subshining and with a slight aeneous reflection; first segment without median marginals;

second with a small, depressed pair rather far apart in the described specimen; third with a large pair, fourth with a marginal row. Genital segments small, wholly black, with small black hair, the second segment with two small bristles turned up behind. Forceps minute, black, diverging only at tip, in profile of rather even width, bearing a small tooth at the middle of the blunt tip. Accessory plate yellow, shining, rounded, not much produced apically. Posterior clasper not visible in the specimen, anterior minute, depressed forward. Penis small, blackish, distinctly jointed, the distal segment somewhat globose, its main sclerite forming the back and sides has a thick, rounded, transverse rim at apex, in front of which in the middle is a small protuberance. Fifth sternite wholly retracted in the specimen.

Legs black, middle femur without comb, middle tibia with one bristle on outer front side, hind tibia without villosity; claws and pulvillia large, the latter infuscated.

Wings hyaline; third vein with a row of six or eight hairs; fourth vein ending nearer apex than in most species (less than half the fifth costal segment); third costal segment slightly shorter than fifth.

Length 5 mm.

Described from a single male, reared by Ray T. Webber from a puparium which he took out of a spider's web at Somerville, New Jersey, on June 23, 1922.

Type.—Male, Cat. No. 27099, U.S.N.M.

The nearest relative is *davidsoni*, Coquillett, which has been reared from spiders' eggs; *subaenescens* differs from this species in having no anterior acrostichals, thinner pollen, a slight aeneous cast to the color of the abdomen, etc. It is highly probable that *subaenescens* attacks spiders' eggs.

Family TACHINIDAE

Genus ATACTA Schiner

Atacta Schiner, Novara Reise, 1868, p. 328. Type and sole species *brasiliensis*, new.

Atactomima Townsend, Bulletin Amer. Mus. Nat. Hist., vol. 35, 1916, p. 15. Type and sole species *crescentis*, new, from Brazil.

The characters of *Atacta* are in brief as follows: Head wider than thorax, subhemispherical; front in male strikingly narrow above (about twice the ocellar triangle), the eyes diverging at a wide angle to the level of the antennae, parafrontals somewhat triangular in form, usually silvery, covered with dense hair, frontal stripe only about as wide as ocellar triangle; only one vertical on each side. Female with wide front, the parafrontals slightly inflated, very broad, with a long dark, translucent reflecting spot on each bearing

a row of five orbitals, the uppermost of which is reclinate. In both sexes the ocellars are present, the frontals diverge below in a broad curve almost to the eye margin at the level of the middle of the second antennal joint; the antennae are slender and small, the second joint equal to the third; the face is very flat, the parafacials bare and wide, the facial ridges bare, the vibrissae distinctly above the edge of the mouth. Bucca in profile about one-fourth the eye height. Palpi and proboscis ordinary. The thoracic chaetotaxy is the same as in *Belvosia unifasciata* Robineau-Desvoidy (*Triachora* of Townsend) and in thorax, abdomen, legs and wings there are no generic characters unlike the latter.

Brauer and Bergenstamm include *Brachycoma nigriceps* Van der Wulp in Atacta from a specimen [4]; but as the third antennal joint is twice the second I doubt if they understood the genus as herein restricted.

The species *crescentis* Townsend seems clearly congeneric from the male in the National Museum; the characters given by Townsend for the genus *Atactomima* are all specific in my opinion.

TABLE OF SPECIES

1. Fourth abdominal segment covered with dense golden pollen; hair of median portion of second and third abdominal segments recumbent; second abdominal segment almost always destitute of median marginals; male with silvery parafrontals________________________**brasiliensis** Schiner.
   Fourth abdominal segment with gray pollen; hairs of median region of second and third abdominal segments erect; second abdominal segment with a pair of median marginal bristles____________________________ 2
2. Antennae and palpi black, tip of latter yellow______**crassiceps**, new species.
   Antennae with second joint yellow, palpi yellow______________________ 3
3. Male with bright silvery pollen on parafrontals, strongly contrasting with the white or yellowish parafacials_____________**argentifrons**, new species.
   Male with the strongly widened parafrontals more chalky white, almost concolorous with parafacials______________________**crescentis** Townsend.

ATACTA BRASILIENSIS Schiner

Atacta brasiliensis Schiner, Novara Reise, 1868, p. 328.—Brauer and Bergenstamm, Zweifl. Kais. Mus., pt. 4, 1889, p. 96, fig. 57; pt. 5, 1891, pp. 340, 365; pt. 6, 1893.—Townsend, Journ. N. Y. Ent. Soc., vol. 23, 1915, p. 64.—C. S. Brimley, Ent. News, vol. 33, 1922, p. 21.

Brachycoma laticeps Van der Wulp, Biologia Cent.-Amer., Dipt., vol. 2. 1890, p. 92.

Atacta apicalis Coquillett, Revis. Tachin., 1897, p. 83.

Originally described from a female taken in Brazil, and afterward collected by Townsend in Peru, the species ranges northward to the vicinity of Washington. Specimens from North America in the United States National Museum are as follows: One male, Chiriqui Province, Canal Zone, reared from *Remigia repanda* Fabricius by

[4] Zweifl. Kais. Mus., pt. 5, 1891, p. 365.

Zetek (No. 22304); one female, Higuito, Costa Rica (Pablo Schild); one female, Puerto Barrios, Guat., February 24, 1905 (C. C. Deam): one male, Tifton, Georgia, September 8, 1896 (G. R. Pilate, type of *apicalis*); one female, Raleigh, North Carolina, July, 1906 (Brimley): one female, Falls Church, Virginia, May 30 (Banks); and one female, Great Falls, Virginia, August 9, 1923 (Aldrich).

ATACTA CRASSICEPS, new species

Male.—front very narrow at the ocelli, only about twice the width of the ocellar triangle, widening very rapidly to the lower end of the frontal row. The parafrontals are covered with somewhat golden pollen which in most lights gives a brownish or almost black reflection; they are quite protuberant, a little inflated and rather densely covered with erect black hairs. The frontal bristles begin a little below the ocelli and the rows diverge rapidly below, ending close to the eye at the level of the middle of the second antennal joint; ocellar bristles distinct and a dense tuft of hair behind them to the vertex. Inner verticals are developed; face very flat with yellow pollen through which a darker ground color shows on each side; parafacials bare with yellow pollen; its least width nearly equal to the length of the third antennal joint. Antennae black, very slender, the arista short, gradually tapering; its penultimate joint twice as long as broad. Vibrissae considerably above the mouth (two-thirds the length of the second antennal joint) with a group of half a dozen small hairs and bristles above them, the highest a little above the tips of the antennae; palpi and proboscis of ordinary size; bucca one-third the eyeheight. Thorax black with conspicuous stripes of white pollen, which leave between them a pair of abbreviated black stripes in front between the acrostichal and dorsocentral; a pair of complete black stripes beginning just mesad of the humerus and extending to the scutellum; and a short median black stripe beginning at the scutellum and extending forward nearly to the suture. Chaetotaxy: acrostichals, anterior 3, posterior 3; dorsocentrals, anterior 2, posterior 4; intraalars, posterior 3, anterior 1; supraalar 3; postalar 2; humeral 3 and 4; sternopleural 4; scutellum with three equal pairs of the margin, the last of which might be called apical, and one pair discal. Abdomen black with gray reflecting pollen which on the fourth segment becomes more dense and yellowish-gray in color; the second segment with a single pair of marginals; third segment with about five pairs; fourth segment with five or six pairs in a single row considerably before the apex. Genitalia small and concealed, of a rather common type. Fifth sternite with a U-shaped incision, the lobes black and almost bare. Legs black, the middle tibia with three or four bristles on the outer front side, the hind tibia distinctly ciliated on the outer side with one longer bristle below the middle.

Wings hyaline, third vein with four or five bristles at base; fourth vein rather suddenly bent, almost at a right angle from which it curves a little outward reaching the costa considerably before the tip of the wing.

Length 9 mm.

Female.—The front has the two large dark, reflecting spots on the parafrontals as in *brasiliensis*, but the color of the remaining pollen is gray rather than golden. This with the characters given in the table will readily distinguish the two species.

Length 7.5 mm.

Described from three males and one female. The males are from Great Falls, Virginia, August 9, 1923 (Aldrich); Tupelo, Mississippi, September 30, 1921 (H. W. Allen); Hope, Arkansas, August 21, 1922 (received from C. W. Johnson and returned to him). The single female is from Opelousas, Louisiana, April, 1897 (Pilate).

Type.—Male, Cat. No. 26845, U.S.N.M., from Great Falls, Virginia.

ATACTA ARGENTIFRONS, new species

Male.—This species is most nearly related to *crassiceps*, the single male specimen has the front much the same as in *brasiliensis*, the parafrontals having very decided silvery color and being less inflated than in *crassiceps*. The thoracic stripes are the same in all the species which I have seen, but *brasiliensis* is the only one with deep golden pollen on the fourth abdominal segment and without median marginals on the second. The female of this species is unknown.

Length 9.5 mm.

Described from a single male collected in May by H. H. Smith at Corumba, Brazil.

Type in the collection of the American Museum of National History.

ATACTA CRESCENTIS (Townsend)

Atactomina crescentis Townsend, Bull. Amer. Mus. Nat. Hist., vol. 35, 1916, p. 15.

Described from four males and a female in the American Museum. Locality, Chapada, Brazil. One paratype male is in the United States National Museum. The supposed generic characters are very slight except that the parafrontals are quite rapidly widened below, the eye being rather more crescent-shaped than in the other species.

ATACTA NIGRIPALPIS (Van der Wulp)

Brachycoma nigripalpis Van der Wulp, Biologia Cent. Amer. Dipt., vol. 2, p. 98.

Atacta nigripalpis Brauer and Bergenstamm, Zweifl. Kais. Mus., pt. 5, 1891, p. 365.

Not seen by the writer and placed here on account of the statement of Brauer and Bergenstamm. who saw a type specimen. I doubt the generic reference very much as none of the other species have such an elongated third antennal joint.

Genus MASICERA Macquart

Masicera MACQUART, Ins. Dipt. du Nord de la France, 1834, p. 285.—COQUILLETT, Revision of the Tachinidae (Tech. Bull. No. 7, Division of Entomology), p. 113, 1897.

MASICERA ARATOR, new species

Fig. c.

Male.—Front 0.28 of head width (average of four, 0.28, 0.28, 0.26, 0.29); parafrontals light golden pollinose; frontal bristles about eight, the two uppermost rather large, reclinate, the lowest reaching the level of the arista and strongly diverging toward the eyes; one pair of verticals; ocellars large; parafacials silvery from the lowest frontals, at narrowest less than half the width of third antennal joint; first two joints of antennae and usually the base of third red, the third broad and long, almost reaching the vibrissae, four or five times the second; arista of moderate length, hardly thickened basally; face concolorous with parafacials, its ridges rather sharp, bare except close to vibrissae; palpi yellow, ordinary, proboscis short, fleshy; bucca over one-fourth of eye height.

Thorax gray pollinose, with very indistinct darker stripes. Acrostichal 3, 3; dorsocentral 3, 4; humeral 3; posthumeral 2; presutural 2; notopleural 2; supraalar 3; intraalar 3; postalar 2; sternopleural 3; pteropleural 0; scutellum with 3 lateral, 1 apical, not upturned, 1 discal.

Abdomen black with subsilvery basal bands of pollen on segments two to four, which to the naked eye give the impression of being equal to the alternating black bands; under the lens in some angles however the pollen covers most of the segments. First segment with one median marginal pair; second segment with a discal and a marginal pair; third with a discal pair and a marginal row; fourth with two to eight discal and a marginal row. Genital segments rather large, wholly black, with black hair and the second with a pair of bristles directed backward. Inner forceps black, slender, long, deeply divided but not divergent, the tips blunt and slightly bent back. Outer forceps with very peculiar and characteristic shape, long and flat, shining black, beyond the middle suddenly widening backward in a thin, concave margin, the apex sharp and curved a little forward so that the whole apical part suggests a plough share. Fifth sternite large and prominent, black, without special bristles or hairs.

Legs black, claws and pulvilli long, especially the front ones; front tibia with two bristles on outer hind side; middle tibia with one bristle on outer front side near middle; hind tibia on outer hind side subciliate, with one long about middle.

Wings hyaline, fourth vein with oblique and rounded bend, the distance from its tip to extreme apex of wing barely equal to one-half the hind cross vein. Third vein with two to three hairs at base.

Female.—Front 0.30 of head width at vertex, wider anteriorly (one specimen); parafacials slightly wider and third antennal joint narrower (hardly three times the second); abdomen with narrower subsilvery bands, the shining black intervening portion wider; genital organs retracted, no indications of a piercing organ; middle tibia with two bristles on outer front side; hind tibia with irregular bristles on outer hind side, not subciliate.

Length of male, 8 to 8.5 mm; of female, 9 mm.

Described from four males and one female. The type male and allotype female were collected at Linglestown, Pennsylvania, June 15, 1913, and were received from the State Bureau of Plant Industry, Harrisburg, Pennsylvania, through the courtesy of A. B. Champlain. One male was bred "from a large *Tipula* larva" collected by James Fletcher at Chelsea, Quebec (near Ottawa), on May 27, 1906; the puparium was formed on June 3, and the fly emerged on June 27. The puparium will be figured by Charles T. Greene in a later paper. One male was collected by H. C. Fall at Tyngsboro, Massachusetts, on July 26, 1916, and is deposited in the Boston Society of Natural History. The remaining male was collected by R. C. Shannon at Dead Run, Virginia (close to Washington), on June 22, 1913.

Type, allotype, and one paratype.—Both sexes, Cat. No. 27100, U.S.N.M.

Family DEXIIDAE

Genus DEXIA Meigen

Dexia MEIGEN, Systemat. Beschreib., vol. 5, 1826, p. 33.—BAER, Die Tachininen, 1921, p. 160.

DEXIA VENTRALIS, new species

Male.—Front 0.18 of headwidth (average of three, 0.16, 0.18, and 0.19), the middle stripe reddish-brown, the parafrontrals, parafacials, posterior orbits and all below the eye light golden pollinose except a broad brown stripe from the eye downward and forward. Parafacials bare. Head from in front obviously higher than wide. Verticals small (only one pair), frontals 7 or 8 irregular, beginning below the ocelli and ending at base of antennae; vibrissae above mouth, a

few small hairs above them. Antennae small, yellow, separated by a well-developed carina which extends between them at base, although low and narrow here; third joint slender, twice the second, not nearly reaching the vibrissae; arista short with dense erect plumosity. Palpi smallish, yellow; proboscis small, the labella yellow. Bucca one-half the eye height.

Thorax with dense yellow pollen becoming more gray on pleurae, with four narrow incomplete darker stripes. Chaetotaxy: acrostichal 1, 1 (sometimes a second small pair before the prescutellars); dorsocentral 4, 3; humeral 2; posthumeral 1; presutural 1; notopleural 2; supraalar 2; intraalar 2; postalar 2; scutellum with 2 lateral, a large decussate apical pair and a small discal; sternopleural 2; pteropleural minute.

Abdomen mostly yellow in ground color, a variable interrupted median black stripe, and narrow variable black hind margins on last three segments; the inflexed ends of the second and third tergites come together below and are more or less tipped with black, thus forming a variable black median ventral stripe. First segment without median marginals; second with one pair discal and one marginal, other marginals toward the sides; third segment with one or two pairs of discals, and a stout marginal row of 8; fourth segment with irregular discal and apical rows. Genitalia small, yellow, the lobes of the fifth sternite black. The pollen of the abdomen is yellowish and confined to the bases of the last three segments, covering half of the fourth.

Legs yellow, tarsi however black: claws and pulvilli long. Middle tibia with only one small bristle on outer front side; hind tibia with two small on outer hind side.

Wings somewhat brownish; costal spine distinct; fourth vein sharply bent at a right angle, with a slight or distinct stump at the bend, ending not very far before the apex; third vein with only 2 to 5 small hairs at base.

Female.—Looks like a distinct species, but was reared with these males. The abdomen is but little or hardly at all yellow in ground color, the basal pollinose bands contrasting with the shining black apical half on segments 2 to 4. The wing is broader, and the fourth vein curves more distinctly backward beyond the crossvein. Width of front at narrowest (vertex) is 0.38 in one specimen and 0.45 in the other. There are only 5 to 6 frontals, the upper one turned back and outward; the usual two orbitals are large and proclinate. The usual two pairs of verticals are present.

Length of male, 8.6 to 10.3 mm.; of female, 7.5 and 8.4 mm.

Described from seven males and two females, reared from scarabaeid beetles at Suigen, Korea, by C. P. Clausen and J. L. King.

Type.—Male, Cat. No. 27245, U.S.N.M.

The species is strictly congeneric with *Dexia rustica* Fabricius of Europe, type of the genus. It agrees very well with the description of *Dexia divergens* Walker, described from Mount Ophir [5]; but one of our specimens was compared with Walker's type in the British Museum by Dr. J. D. Tothill and showed differences apparently specific.

Genus EUTRIXOPSIS Townsend

Eutrixopsis Townsend, Insecutor Inscitiae Menst., vol. 6, p. 166, 1918.

This genus was based upon the single species *javana*, described by Townsend on the same page; only a single specimen was known, a male from Java. The species has recently been found by Clausen and King, of the United States Bureau of Entomology, to be an important parasite of the "Japanese Beetle," *Popillia japonica* Newm., in Japan. Their studies of its biology and economic relations will be published elsewhere.

The genus differs from *Eutrixa* (inclusive of *Eutrixoides* Walton) chiefly in having much narrower parafacials and broader and flatter facial ridges; in other words, the suture encloses a much broader portion of the head below. The parafacial also bears close to the eye a more or less double row of hairs. Both genera are parasitic on melolonthine beetles in the adult stage.

Since *javana* has been only briefly described hitherto, its economic importance requires that it be given a full description here.

EUTRIXOPSIS JAVANA Townsend

Eutrixopsis javana Townsend, Insecutor Inscitiae Menst., vol. 6, p. 166, 1918.

Male.—A brown fly with mostly yellow abdomen and legs. Eyes almost contiguous on the front, separated by less than the width of the anterior ocellus, ocellar triangle small, elevated; ocellar and vertical bristles absent, no hairs on front above middle, a few small bristles below stopping short of the lunule; small hairs begin on lower parafrontals and continue down the narrow parafacials in a mostly double row to the lower end of the lunule. Antennae brown, very small, third joint twice the second, arista pale, about three times as long as the third joint, bare, its penultimate joint short. Facial ridges flat, converging below and at the closest point separated by hardly more than the width of the third antennal joint. No vibrissae, the ridges hairy in this region and bearing a few small but increasing bristles toward the mouth, which is some distance below. Palpi and proboscis ordinary, the former yellow. Back of head concave above, convex below. Bucca half the eye height, the

[5] Proc. Linn. Soc., vol. 1, 1856, p. 21.

large transverse impression ending vertically below the eye. Thorax brown with smooth, silky gray pollen and two narrow brown stripes near middle. Chaetotaxy: Acrostichals, 1 next to scutellum; dorsocentrals, 3 anterior, 4 posterior; intraalar 1, supraalar 1; postalaar 2; humeral 1 or 2; prescutellar 1; notopleural 2; scutellum with 2 lateral, 1 apical of same size, 1 discal; sternopleural 2. Calypters whitish.

Abdomen yellow in ground color, with thin gray pollen; segments 1–3 with narrow posterior dark band and a dark middle line of same width. First segment without marginal bristles; second with a small median pair; third with marginal row of about 12, not large. Genital segments yellow, small, hairy; inner forceps united into a small slender yellow process curving forward, blunt at tip; outer forceps yellow, slender, as large and long as the combined inner ones. Fifth sternite with broad yellow lobes, separated by a broad V-shaped incision.

Legs yellow; tips of hind femora infuscated and all the tibiae with faint dark reflections in certain lights. Claws long and pulvilli nearly equal to last tarsal joint. Wings subhyaline, third vein with two or three hairs at base.

Length, 6 to 7 mm.

Female.—Front considerably wider than front ocellus; as the only specimen is somewhat shriveled, the front may normally be almost as wide as the ocellar triangle. Claws long for a female, but not so long as in the male; pulvilli rounded, more than half as long as last tarsal joint. Whether any sort of piercing larvipositor is present is not clear; the organs have been unsuccessfully pulled apart. There may be a minute piercer, but in any event smaller than the very distinct one of *Eutrixa exilis* and not comparable with the large one of *jonesi.*

Length, 6 mm.

Five males and six females, reared at the Japanese beetle laboratory from adults of the so-called Japanese beetle, *Popillia japonica* Newman; the infested beetles were obtained in Japan.

Type.—Male, Cat. No. 26846, U.S.N.M.

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PLANT AND INSECT FOSSILS FROM THE GREEN RIVER EOCENE OF COLORADO

By T. D. A. Cockerell

Of the University of Colorado, Boulder

The present paper continues the study of the Green River biota, the fossils now described having been obtained by Mrs. Cockerell, John P. Byram, and the writer during the summer of 1922. The oil shale region in Colorado is at the present time in a condition extremely favorable to the paleontologist, owing to the great quantities of shale thrown out from the very numerous assessment holes. In a few years this material will decay, and it is probable that the blasting out of fresh holes will be discontinued. The rock is very hard and can not be readily worked with pick and shovel, as is done at Florissant. We may therefore hope that means will be found in the near future to send additional collectors into the region, to secure the rich materials now readily obtainable.

Since I last published on this subject Dr. F. H. Knowlton's excellent Revision of the Flora of the Green River Formation [1] has appeared. This puts our knowledge of the flora, hitherto very imperfect and confused, on a good basis and makes further work relatively easy. One previously published species has been omitted; *Firmianites aterrimus* Cockerell [2] (Green River, Wyoming).

The new materials now described indicate certain general conclusions or results as follows:

(1) The plants show that the flora is in many ways similar to that of Florissant, with enough representative species to strongly suggest that part of the Florissant flora is directly descended from that of the Green River Epoch; while at the same time there has been interval enough to change all or almost all the species. It is probable that no Florissant species of flowering plant is actually identical with any Green River species.

(2) On the other hand, it is evident that part of the Florissant flora is derived from quite other sources; also that the Green River climate was warmer than that of Florissant. As we come to know

[1] U. S. Geological Survey, Professional Paper 131–F.

[2] Amer. Journ. Sci., November, 1909, p. 447.

more of the Green River biota, the comparisons with Florissant will certainly give results of great value and interest.

(3) The Proteaceae are in this paper clearly established in the Green River. The previously recorded *Lomatia microphylla* Lesquereux cannot be considered definitely Proteaceous.

(4) The Green River biota is by no means strictly or typically tropical though it contains elements suggestive of tropical or subtropical conditions.

HEPATICAE

Family JUNGERMANNIACEAE

LEJEUNEA EOPHILA, new species

Plate 1, fig. 1

Stem fairly stout, normal, bearing poorly preserved thin rounded leaves, apparently 3 mm. long or less, and well developed bifid underleaves, the latter about three in 5 mm. of stem; underleaves with very stout bases, the lobes more or less unequal, one thick, the other slender, both pointed, with their outer sides convex and inner concave; length of underleaf about 1.5 mm. The specimen consists of about 16 mm. of stem, with leaves.

Green River shales, head of East Alkali Gulch, about 8 miles south of DeBeque, Colorado; collected by John P. Byram in 1922.

Holotype.—Cat. No. 36851, U.S.N.M.

So far as can be seen, this does not differ from modern *Lejeunea.* Bifid underleaves and other characters readily distinguish it from *Jungermanniopsis cockerelli* Howe and Hollick of the Florissant Miocene. *Lejeunea eophila* is the oldest known member of the *Jungermanniaceae.* It might have existed in a tropical or subtropical habitat.

EQUISETALES

Family EQUISETACEAE

EQUISETUM WYOMINGENSE Lesquereux

Green River shales, head of East Alkali gulch, about 8 miles south of DeBeque, Colorado (J. P. Byram 1922). New to Colorado.

Family SCHIZAEACEAE

LYGODIUM KAULFUSSII NEUROPTEROIDES (Lesquereux)

Lygodium neuropteroides Lesquereux, U. S. Geol. and Geogr. Surv. Territ., Annual Report for 1870, p. 384.

Since the Green River plant is not strictly identical with the European Eocene form, it seems best to retain the name proposed by Lesquereux in a subspecific sense.

Green River Eocene Station 2, large excavation with tunnel at head of Salt Wash, Roan Mountains, Colorado, 1922. Also obtained by Mrs. Cockerell at Station 1, on Ute trail.

This genus illustrates the difficulty of drawing conclusions concerning past climates from single species. *Lygodium* is in general a tropical genus, but the living *L. palmatum* (Bernhard) Swartz extends north to Massachusetts.

Family SALICACEAE

POPULUS WILMATTAE, new species

Plate 2, fig. 8

Leaf broad, with approximately the shape of *P. trichocarpa* Hooker, length about or nearly (apex missing in type) 70 mm., width 71 mm.; base broadly truncate; margins distinctly but feebly and rather remotely dentate, the low obtuse teeth about 2 to 3 mm. apart; petiole about 1.5 mm. thick; midrib and two pairs of lateral veins very prominent, the first pair coming off at the base, the second about 3.5 mm. beyond, the latter at an angle of about 45°; the weak veinlets from the midrib above widely diverging, not far from transverse.

Green River Eocene, Roan Mountains, Colorado, 1922, Station 2, excavation at head of Salt Wash. Named after Mrs. Cockerell.

Holotype.—Cat. No. 36852, U.S.N.M.

Of all the forms of *Populus* known to me this most resembles the living *P. rasumowskiana* Dippel, which I saw growing in Kew gardens. The form and appearance are closely similar, but the fossil differs in lacking any really strong lateral veins above the two pairs near the base. Thus the venation, though not the shape, is more like that of the fossil *P. zaddachi* Heer.

Family MELIACEAE

MELIA COLORADENSIS (Knowlton)

Phyllites coloradensis Knowlton, Revis. Flora Green River Formation, U. S. Geol. Surv., Prof. Paper 131–F, p. 176.

This appears to be a *Melia*, related to *M. expulsa* Cockerell from Florissant Miocene. We obtained it at Station 1, on Ute trail, and Station 2, near head of Salt Wash, Roan Mountains, Colorado. The terminal leaflet may be deeply notched, as Knowlton shows one of the lateral ones to be. The leaflets are larger than in *M. expulsa*, without any serration of the margin. In the living *M. azedarach* Linnaeus forms occur with the margins of the leaflets nearly entire. The living species inhabit Asia and Australia. The figure of *Phyllites winchesteri* Knowlton looks like a distorted leaflet of this species, but the description entirely negatives such an idea.

Family ANACARDIACEAE

RHUS VARIABILIS (Newberry) Knowlton

At Station 2, near head of Salt Wash, Roan Mountains, Colorado, we found a very fine leaf with nine leaflets, showing the petiolules about 8 mm. long, the bases of the leaflets narrowly cuneate, the serrations coarse and few. Newberry's figure cited by Knowlton is not quite so coarsely toothed, but is doubtless the same thing. Newberry did not intend to take this leaf as typical of his species, but Knowlton has so restricted it, and must be followed. Knowlton's figure 11, of his *Rhus myricoides*, appears to be the same species, but apparently not figure 9, to which *R. myricoides* should be restricted. The leaflets of *R. variabilis* are widely spaced, the petiolules about 20 mm. apart.

Family CELASTRACEAE

EVONYMUS FLEXIFOLIUS Lesquereux

The apical portion of a leaf, showing the very characteristic features, was collected by Mrs. Cockerell in the Green River shales at Station 1, near head of Ute trail, Roan Mountains, Colorado. The species has previously been known only by the unique type collected in Wyoming. The long "drip-tip" suggests a moist climate.

Family SAPOTACEAE

BUMELIA COLORADENSIS, new species

Plate 1, fig. 5

Leaf apparently coriaceous, long oval, inequilateral and emarginate at apex, broad-cuneate at base, entire, with a short somewhat twisted petiole. Principal lateral veins few, widely spaced, about 6 to 8 mm. apart with short veins between their bases. Leaf about 60 mm. long and 32 wide, the widest part above the middle.

Green River Eocene, Roan Mountains Colorado, Station 2, large excavation at head of Salt Wash, 1922.

Holotype.—Cat. No. 36853, U.S.N.M.

This may as well be *Mimusops* as *Bumelia*, but it is evidently allied to *Bumelia florissanti* Lesquereux from the Miocene of Florissant, differing by being oval rather than pyriform in outline. It does not agree with any of the numerous fossil species described by Berry. It is indicative of a tropical or warm-temperate climate. Knowlton's *Carpolithus caryophylloides*, as figured, has the aspect of a *Mimusops* calyx. Could it belong to the plant now described?

Family ARALIACEAE

ARALIA WYOMINGENSIS Knowlton and Cockerell

Green River Eocene, Roan Mountains, Colorado, 1922, Station 8, half a mile east of our camp at head of Ute trail. A leaf of the same size as that figured by Knowlton,[3] but differing from Knowlton's figure and agreeing with Newberry's in having the principal lateral veins arising some distance above the base of the leaf.

Family FABACEAE

DALBERGIA KNOWLTONI, new species

Plate 1, fig. 3

Leaflet apparently coriaceous, oval with broadly angulate slightly inequilateral base and deeply emarginate (in the type strongly inequilateral) apex; margins entire. Length 40, width 25.5 mm.

Green River Eocene, Roan Mountains, Colorado, 1922, Station 8, near head of Ute trail.

Holotype.—Cat. No. 36854, U.S.N.M.

This is evidently identical with Knowlton's *D. retusa*, but as that name has been used twice, earlier, for living species, I take my specimen, which is better than Knowlton's, as the type.

AMORPHA UTENSIS, new species

Plate 2, fig. 6

Leaflet 12 mm. long, 5 mm. across near apex, cuneate, with entire margins, apex broadly truncate and strongly mucronate; petiolule rather stout 3 mm. long.

Green River Eocene, Roan Mountains, Colorado, 1922. Station 1, near head of Ute trail.

Holotype.—Cat. No. 36855, U.S.N.M.

This leaflet is exactly as in *Amorpha*, but unusually cuneate at base.

Family CLETHRACEAE

CLETHRA(?) LEPIDIOIDES, new species

Plate 2, fig. 7

A slender flexible raceme, with crowded small fruits in the manner of *Clethra alnifolia* Linnaeus. Fruits globose, about 2.3 mm. in diameter, on short petioles, apparently enclosed in a calyx; raceme as preserved about 35 mm. long (but the end is missing) and 4 to 5 mm. wide, pure black.

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[3] Revis. Flora, Green River Formation, pl. 4, fig. 12.

Green River Eocene, Roan Mountains, Colorado, Station 1, near head of Ute trail (Wilmatte P. Cockerell, 1922).

Holotype.—Cat. No. 36856, U.S.N.M.

It is impossible to prove that this is a *Clethra*, but it has that appearance. The genus contains two living North American species, and there is a species (*C. arborea* Aiton) living in Madeira.

The flowers of *C. berendtii* Caspary have been beautifully preserved in Baltic amber. *C. lepidioides* certainly shows much resemblance to the fossil *Andromeda protogaea* Unger, but I do not believe it is an *Andromeda*. The specific name is derived from the superficial resemblance to *Lepidium*.

Family ROSACEAE

POTENTILLA(?) BYRAMI, new species

Plate 2, fig. 9

Calyx with four acuminate sepals, having an expanse, from tip eto tip of 10.5 mm., the width of a sepal near base 2 mm., the sides with a double curve free from hairs; corolla deciduous, absent; stamens very numerous, at least 20, with rather stout filaments about 1.8 mm. long and globose or subglobose anthers.

Green River Eocene, Roan Mountains, Colorado, Station 11, near top of ridge just beyond that on which is Station 1, on the side facing the latter (John J. Bryam, 1922).

Holotype.—Cat. No. 36857, U.S.N.M.

This seems to agree well with those forms of *Polentilla* which have sometimes been separated as *Tormentilla*, on account of the tetramerous flowers. The group is more characteristic of Europe than America at the present time. Although the generic reference remains somewhat uncertain, it is strongly suggested by the form of the sepals, the quickly deciduous petals, and the character of the numerous stamens.

Family ALSINACEAE

ALSINITES, new genus

Plant small, tufted with crowded flowers solitary on short stems, apparently arising separately from the tufted caudex; leaves apparently minute, not descernible; pedicels slender, 5 mm. long or less; flowers narrowly campanulate, with tapering (not abrupt or swollen) base; calyx with apparently five lobes, separated about halfway to base, rather narrow, with somewhat obtuse tips; corolla apparently absent; stamens ten, parallel, strongly exserted, with well developed anthers; capsules globose, smooth, with apparently mucronate apex.

Type of the species.—Alsinites revelatus, new species.

ALSINITES REVELATUS, new species

Plate 1, fig. 2

Calyx about 5 mm. long and 2.5 mm. broad; stamens exserted about 3.5 mm., with rather stout filaments; anthers oval hardly half a mm. long; capsules about 2 mm. in diameter.

Green River shales; spur above Roan Creek opposite Salt Wash, just beyond the spur on which is the Ute trail. Found, 1922, by John P. Byram.

Holotype.—Cat. No. 36858, U.S.N.M.

This is the first fossil caryophylloid plant from North America, with the possible exception of *Carpolithus caryophylloides* Knowlton, also of the Green River Eocene of Colorado, which has the base of the calyx (?) much broader and more abruptly separated from the pedicel. This comparison is based on the supposition that it is a calyx, but Knowlton prefers to consider it a capsule more or less resembling that of *Lychnis*, in which case the resemblance to *Alsinites* is even more remote.

Plants of this type exist in rocky and mountainous places, even in the tropics, but not in the humid lowlands. Presumably *Alsinites* grew on some mountain overlooking Green River lake and was washed down to the bottom of the valley as the result of a storm. Such specimens, only preserved as the result of a fortunate accident, are unusually precious and interesting.

Alsinites differs in no very marked characters from the modern *Alsine*, but it has a facies of its own and by reason of the long exserted stamens and absence of corolla may be considered generally distinct.

Family PROTEACEAE

LOMATIA OBTUSIUSCULA, new species

Plate 1, fig. 4

Similar to *L. terminalis* Lesquereux, from the Florissant Miocene but the ends of the lobes of the leaf are obtuse instead of acutely pointed. The type is the end of a leaf, 38 mm. long, intense black as preserved. The venation only visible on wetting, the original texture evidently coriaceous. The apical lobe is lanceolate, 18 mm. long and 7 mm. broad, obtuse at tip; there are two lateral lobes on each side, those on one side with the upper margin 5 mm. long, on the other longer, 6 or 7 mm., and all obtuse and directed obliquely apicad.

Green River Eocene, Roan Mountains, Colorado, at Station 1, near head of Ute trail (Cockerell, 1922).

Holotype.—Cat. No. 36859, U.S.N.M.

The reference to *Lomatia* follows the usage for the Florissant fossils but actually the genera of Proteaceae can hardly be separated on the leaves. The living *Lomatia ferruginea* R. Brown and *L. tinctoria* R. Brown have foliage of the general type of *Grevillea robusta* A. Cunningham; while *L. obliqua* R. Brown, *L. dentata* R. Brown, and *L. polymorpha* R. Brown are entirely different. Were they all fossilized, they certainly would not be regarded as congeneric. I take this opportunity to note that the reference to fossil leaves resembling *Grevillea*, in American Museum Journal (vol. 16, p. 449), has to do with *Lomatia acutiloba*. The editor (p. 447), unfortunately inferred that the species figured (*L. tripartita*) was referred to, and this was later the occasion for a criticism from a South African botanist who does not believe in North American Proteaceae.

BANKSITES LINEATULUS, new species

Plate 2, fig. 3

Seed about 2.5 mm. long and 1.5 broad, with wing 5.8 mm. long the base of which falls short of end of seed about 1.6 mm.; the wing is 3 mm. broad, with six or seven widely spaced delicate veins; it is obtuse and inequilateral, and wing and seed together measure 7 mm. in length.

Green River Eocene, Roan Mountains, Colorado, at Station 2 of 1922 expedition, large excavation with tunnel at head of Salt Wash, some distance below top of hill (Cockerell).

Holotype.—Cat. No. 36860, U.S.N.M.

This is extremely similar to *B. lineatus* Lesquereux from the Miocene of Florissant but smaller and presumably a different species. It differs little from the seeds of living Proteaceae; there is even some suggestion of the projecting point near the upper end of the seed which is seen in *Banksia*. In *Banksia integrifolia* Linnaeus filius, the wing goes less than half way down the side of the seed; in *Banksites lineatulus* it goes much more than half way, but not nearly so far as in *Knightia excelsa* Robert Brown, in which it goes practically to the end.

The fossil leaves described as *Banksites saportanus* Velenovsky, recorded from the Upper Cretaceous of Marthas Vineyard, are much more like *Knightia* than *Banksia*.

Family HAMAMELIDACEAE

LIQUIDAMBAR CALLARCHE, new species

Plate 1, fig. 6; plate 2, fig. 5

Leaves similar in size and appearance to those of the living *L. styraciflua* Linnaeus, five-lobed, the lobes without accessory lobules, the basal margin (dentate in *L. styraciflua*) entire, sides of median

lobes with low obtuse teeth at intervals of about 7 mm, and only faint indications of denticulation between. The points in no case as distinctly produced as in *L. styraciflua.* I am unable to see any pubescence in the axils of the veins (it is absent in *L. orientalis* Miller of Asia Minor), but the state of preservation admits of no certainty in this regard. Fruit about 15 mm. in diameter, on a slender stalk, in all respects typical of the genus, the hardened projecting styles very numerous, slender, and straight or nearly so, features which distinguish the species from *L. europaeum* A. Braun.

Green River Eocene, Roan Mountains, Colorado, leaf found at Station 2 of 1922 expedition (head of Salt Wash) by John P. Byram. This may be taken as the type.

Holotype.—Cat. No. 36861, U.S.N.M.

Fruit found by Mr. Byram at head of East Alkali Gulch about eigth miles south of DeBeque, Colorado. The probability that the fruit and foliage belong together is so strong that this is presumed to be the case. This is not the European Miocene *L. europaeum*, the leaves of which agree in form and outline with *L. styraciflua.* (On the view that names of trees are feminine, we ought to write *L. europaea*). The so-called *L. europaeum* described from the American Eocene may be at least in part identical with *L. callarche.*

L. convexum Cockerell, from Florissant, is distinguished from the present species by the convex sides of the middle lobe of the leaf.

INSECTA

COLEOPTERA

Family ELATERIDAE

CARDIOPHORUS EXHUMATUS, new species

Plate 2, fig. 2

Length 9 mm., elytra 6 mm.; width of thorax 2.7 mm., length about 2.3 mm.; width of elytra in middle 1.5 mm. Thorax with sharply pointed posterior angles; elytra narrow, subacute, with eight very delicate, not punctate, striae, the whole surface apparently delicately pubescent. The metasternal cavity, middle coxal cavities, metasternum and hind coxal plates appear to agree with *Cardiophorus*, as also the delicately hairy feebly striate elytra. On comparison with the living *C. pubescens* Blanchard, from White Rocks, Boulder County, Colorado, the hind coxal plates are more pistol-shaped, narrower mesad, with the upper margin convex and the lower (posterior) concave. Also, the metasternal plates appear to be more obtuse or rounded at the outer hind corner than in *C. pubescens.* The scutellum is unfortunately not preserved. The elytra are without spots.

Green River Eocene; head of East Alkali Creek, about 8 miles south of DeBeque, Colorado (John P. Byram, 1922).

Holotype.—Cat. No. 69614, U.S.N.M.

The broad thorax, with convex sides and the elytra without evident punctures at once separate this from *C. braunii* Heer, from the Miocene of Oeningen. Among the Florissant (Miocene) species, it is perhaps nearest to *C. lithographus* Wickham, but the hind coxal plates are differently shaped. This is much the oldest known *Cardiophorus.*

Family SCARABAEIDAE

MELOLONTHITES AVUS Cockerell

A specimen about 11.5 mm. long was found by John P. Byram at our Station 10, which is a large excavation a short distance up the Ute trail from Station 1, in the Roan Mountains, Colorado. The clypeus is emarginate but not at all bidentate; the eyes are deeply emarginate, the elytra are strongly convex outwardly, and the hind spurs are very strongly curved. The insect is quite modern in appearance and may, I think, be termed *Phyllophaga avus*, though the protuberance on the outer side of the hind tibiae is very indistinct.

HEMIPTERA

Family CIXIIDAE

EOLIARUS, new genus

Resembling the modern genus *Oliarus* Stal, both in form and the spotting of the wings, but the radius branches at an acute angle a considerable distance before the large stigmatic spot, the upper division (R) proceeding very obliquely to the margin, traversing the upper part of the spot; the lower division (radial sector) emitting four very oblique branches above (as in the Mesozoic *Mesocixoides* of Tillyard), the first traversing the stigmatic spot, the second arising at its outer lower corner, the fourth traversing the upper part of the apical spot; media branching beyond level of forking of radius, its fork more open, the upper branch soon connected with the radial sector by a vertical cross-vein, and later forking at an acute angle, its upper division again forking at the level of the last branch of radial sector; cubitus forking at same vertical level as radius; hind wings with cross-veins beyond the bases of apical forks; body very stout, brown, pallid in scutellar region, abdomen distinctly branded.

Type of the genus.—*Eoliarus quadristictus*, new species.

EOLIARUS QUADRISTICTUS, new species

Plate 2, fig. 1

Length about 8 mm., width of abdomen near base 3.5 mm.; length of tegmen 9 mm., distance between stigmal and apical spots 2 mm ; wings hyaline with brown (not spotted) veins; four conspicuous spots, the large irregularly quadrate stigmal one, the smaller apical one, a small one near lower side of wing directly below stigma and another subapically in the region of the end of the cubitus. The venation differs to some extent on the two sides of the type. On the right side the upper branch of the media forks very near to the cross-vein, while on the left it forks at a distance a little greater than the length of the cross-vein.

Green River Eocene, Trail Gulch, on north side of Roan Creek, Colorado (John P. Byram, 1922).

Holotype.—Cat. No. 69615, U.S.N.M.

Oliarus (?) *lutensis* Scudder, from Green River, Wyoming, is clearly congeneric and must be called *Eoliarus lutensis.* Possibly the two forms belong to a single species, but in *lutensis* the fork of the upper branch of media is very much more distant, the tegmina do not appear to be distinctly four-spotted, and the insect is considerably smaller. I should nevertheless have hesitated to propose a second species were it not that in the modern genus *Oliarus* there are very numerous species, differing by similarly inconspicuous or relatively unimportant details. This insect gives us another example of spotting which is older than the finer details of structure.

Family CICADELLIDAE

THAMNOTETTIX PACKARDI, new species

Plate 2, fig. 4

Length 4 mm.; length of tegmina 4 mm.; their width about 1.4 mm.; width of thorax about 1 mm. or slightly more. Head and body dark, with scutellar region pale; tegmina slender, with longitudinal light and dark stripes. There is a dark line along the costa, perceptibly broadening basally; below the costa, nearly to the end of the wing, is a broad continuous pale band emitting a pointed lobe, directed apicad, from its basal third beneath; beyond this pointed lobe, separated from it by an oblique dark band, is an elongate pale mark but the apical part of the wing is dark; a broad light band covering the upper margin of the clavus, and a narrow curved light band in the extreme anal region. Hind wings strongly dusky; no visible marginal vein.

Green River Eocene, Roan Mountains, Colorado, 1922; Station 11, near top of ridge beyond that on which is Ute trail (John P. Byram); also a poorer specimen, found by Mrs. Cockerell.

Holotype.—Cat. No. 69616, U.S.N.M.

Scudder's *T. gannetti*, based on two specimens collected by Dr. A. S. Packard at Green River, Wyoming, is certainly very similar, but the specimens are not very well preserved. It is not certain that both specimens pertain to the same species, but one of them (Scudder's pl. 6, fig. 33), may actually be *T. packardi.* I will therefore take as the type of *T. gannetti* the other specimen (Scudder's pl. 7, fig. 5). The new species is named after the eminent discoverer of Scudder's *T. gannetti.* The venation of the hind wings in *T. packardi* is entirely of the same type as that of *T. eocenica* (Cockerell), but the latter is readily separable by the marking of the tegmina.

DIPTERA

Family TIPULIDAE

CYTTAROMYIA OBDURESCENS, new species

Female.—Length about 9.5 mm.; length of wing 9.5 mm.; its width 2.5. Thorax very small, dark brown; abdomen paler, subclavate. Wings pale brown throughout, quite without spots. The following measurements are in microns; length of discal cell about 1800, its width near end about 608; length of posterior cells beyond discal about 1360; length of marginal cell 3450, the proximal portion considerably longer than distal; cell above discal extending 320 beyond it; end of second basal 176 beyond basal corner of discal. Praefurca very strongly arched at base, not as long as rest of second longitudinal vein, but very much more than half as long.

Green River Eocene, Roan Mountains, Colorado, 1922, Station 11 (John P. Byram).

Easily known from *C. fenestrata* Scudder by the longer discal cell and absence of a dark cloud in end of marginal cell. In Scudder's table it runs nearest to *C. cancellata* Scudder, from Florissant, but is readily separated by the more produced cell above discal and the second basal extending more below base of discal.

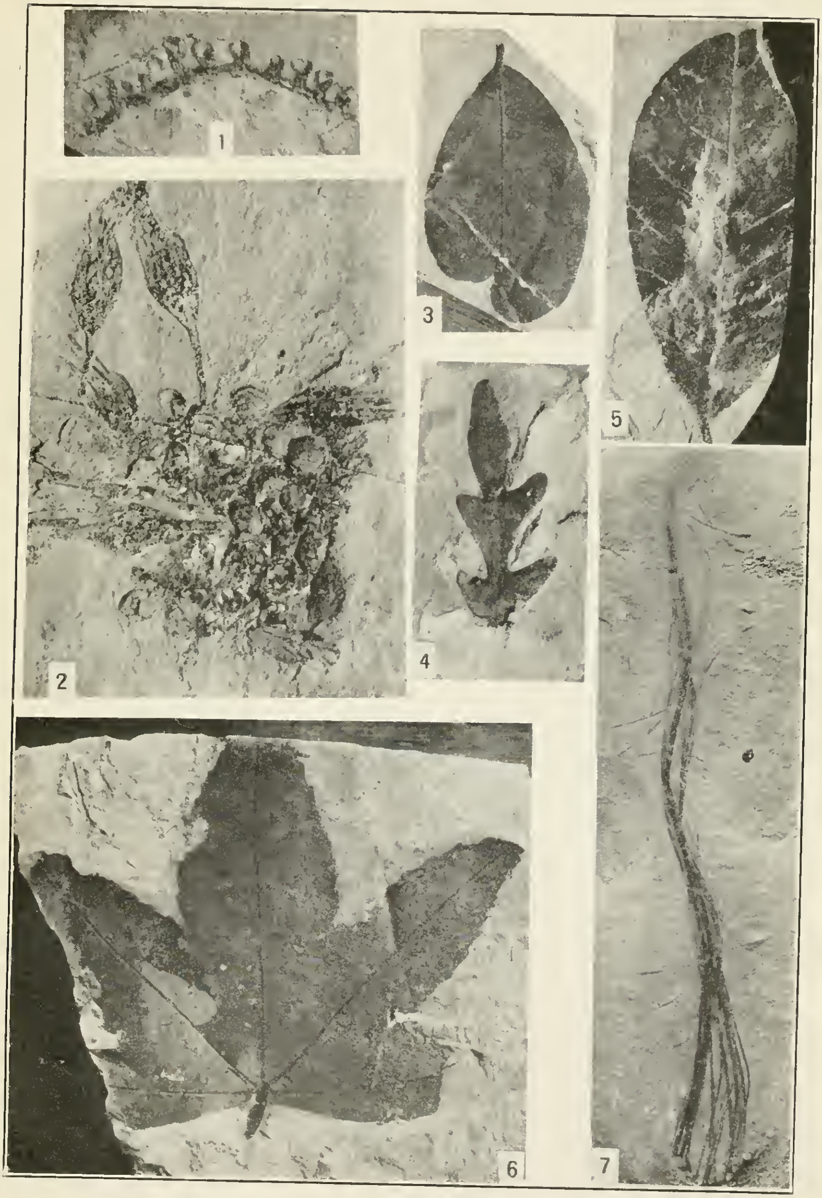
EXPLANATION OF PLATES

Plate 1

Fig. 1. *Lejeunea eophila*, new species, × 2.5.
2. *Alsinites revelatus*, new species, × 2.5.
3. *Dalbergia knowltoni*, new species, natural size.
4. *Lomatia obtusiuscula*, new species, natural size.
5. *Bumelia coloradensis*, new species, natural size.
6. *Liquidambar callarche*, new species, natural size.
7. *Diatryma filifera* Cockerell, natural size.
(Feather, described in Amer. Mus. Novitates, No. 62 (1923).)

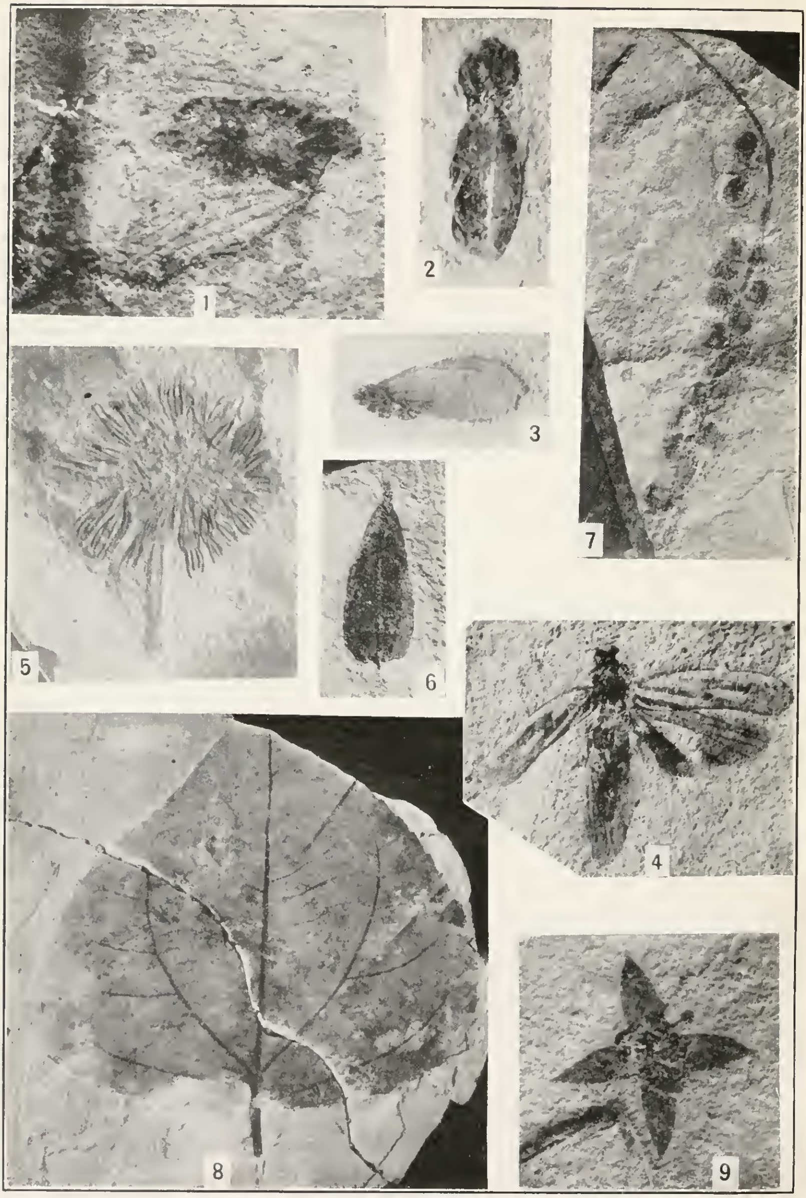
Plate 2

Fig. 1. *Eoliarus quadristictus*, new species, × 3.
2. *Cardiophorus exhumatus*, new species, × 3.
3. *Banksites lineatulus*, new species, × 3.
4. *Thamnotettix packardi*, new species, × 6.
5. *Liquidambar callarche*, new species, × 2.5.
6. *Amorpha utensis*, new species, × 2.
7. *Clethra lepidioides*, new species, × 2.
8. *Populus wilmattae*, new species, × 1.
9. *Potentilla ? byrami*, new species, × 3.



FOSSILS FROM THE GREEN RIVER EOCENE

FOR EXPLANATION OF PLATE SEE PAGE 13



FOSSILS FROM THE GREEN RIVER EOCENE

FOR EXPLANATION OF PLATE SEE PAGE 13

A RARE CRETACEOUS SEA URCHIN, SCUTELLASTER CRETACEUS CRAGIN

By John B. Reeside, Jr.,

Of the United States Geological Survey.

The genus *Scutellaster* was instituted in 1895 by F. W. Cragin [1] for the reception of a specimen "from the arenaceous shale of the Fox Hills division of the Cretaceous, on the east slope of Shook's Run, on Platt avenue, Colorado Springs, Colorado." The type was not figured and the description given indicated that it was rather imperfect. Clarke [2] in 1915 in his monograph of the Mesozoic Echinodermata of the United States reserved judgment on both genus and species until better material could be found and quoted a statement by Cragin that the latter had come to doubt the validity of the genus *Scutellaster*. No other specimens have been found to date, however, and both the extreme scarcity of echinoids in the Cretaceous of the Interior Province and the unusual character of the species in question warrant further description in spite of the imperfect material. The type was originally a part of the Cragin collection of the museum of geology at Colorado College, Colorado Springs, Colo., but is now in the United States National Museum (Cat. No. 32702). The horizon of the specimen is now believed to be in the top of the Pierre shale rather than the Fox Hills sandstone.

Cragin's original description is as follows:

SCUTELLASTER, new genus

Clypeastrid large, combining the flattish-convex, or discoidal, test of *Scutella* with the pentagonal outline of *Clypeaster;* disc without loopholes or any emarginations other than shallow convexities; ambulacral petals closed, or nearly so.

SCUTELLASTER CRETACEUS, new species

Plate 1, figs. 1 and 2

Test as large as that of a large *Scutella*, or that of one of the more moderate-sized species of *Clypeaster*, obtusely pentagonal, its height apparently about equal to, or not more than, one-tenth of its length; ambulacral petals of

[1] Cragin, F. W., A new Cretaceous genus of Clypeastridae: American Geologist, vol. 15, pp. 90–91, 1895.

[2] Clark, W. B., and Twitchell, M. W., The Mesozoic and Cenozoic Echinodermata of the United States: U. S. Geol. Survey Mon. 54, p. 67, 1915.

moderate breadth, reaching to within a short distance of the ambitus, the unpaired and anterior paired petals being straight, the posterior paired ones slightly sinuous; breadth of a pore belt (apparently) about half that of a semiambulacrum, the part of the ambulacrum between the pore belts ornamented with light-colored pancta (the supposed spine scars) arranged in quincunx; interambulacral plates thick, separated by deep sutures that are made especially pronounced by the beveled borders of the plates, the adambulacral half (on distal plates, less than half) of each plate being crossed with slightly raised, parallel curved lines, which subtend the borders of the ambulacral petals and between which are puncta that, like those of the ambulacral midareas, present the appearance of filled pores and are in quincunx, though forming a simple linear series between each two lines; surface of inner, or contiguous, halves of interambulacral plates plain (or at least without lines, and

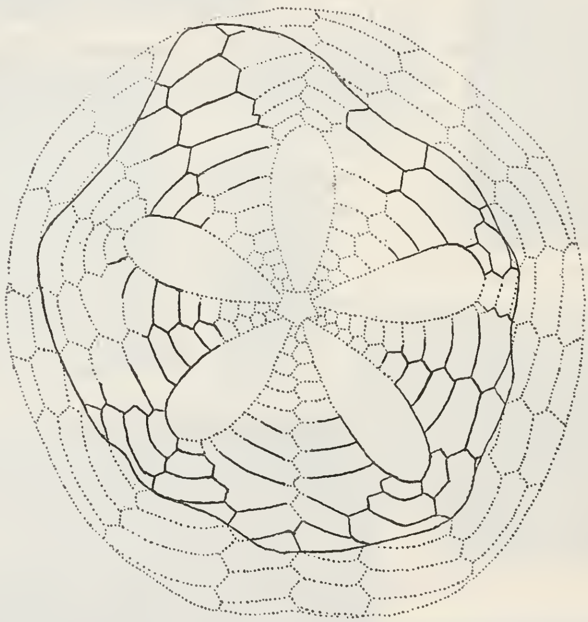


Fig. 1.—Hypothetical Restoration of Scutellaster Cretaceus Cragin, Based on the Type and a Miocene Scutella

with only minute puncta, which, in the type specimen, are mainly obliterated), save near the ends, where a number of coarse puncta are so arranged as to constitute a narrow and indefinitely bounded miliary zone.

Between the anterior and either antero-lateral angle, the outline of the test, as viewed from above, presents two trifling concavities separated by a broader convexity. Between either antero-lateral angle and the posterior angle of the same side, the outline presents a broad and shallow concavity which culminates opposite the anterior part of the posterior row of plates of that interambulacral field. The bottom of the test is not shown in the type, and the posterior border is imperfect, so that the exact form of the latter and the exact position, etc., of the peristome and periproct are unknown.

Measurements.—Length of test, 105; breadth, 83; height (approximately), 8–10 mm.

The writer believes that the genus *Scutellaster* may fairly be regarded as a *synthetic*, or *generalized*, type from which have been evolved *Scutella* on the one hand and *Clypeaster* on the other.

In the present condition of the type, as shown by the retouched photograph forming figure 1 of plate 1, some of the details noted by Cragin are not evident. The ambulacral petals are entirely

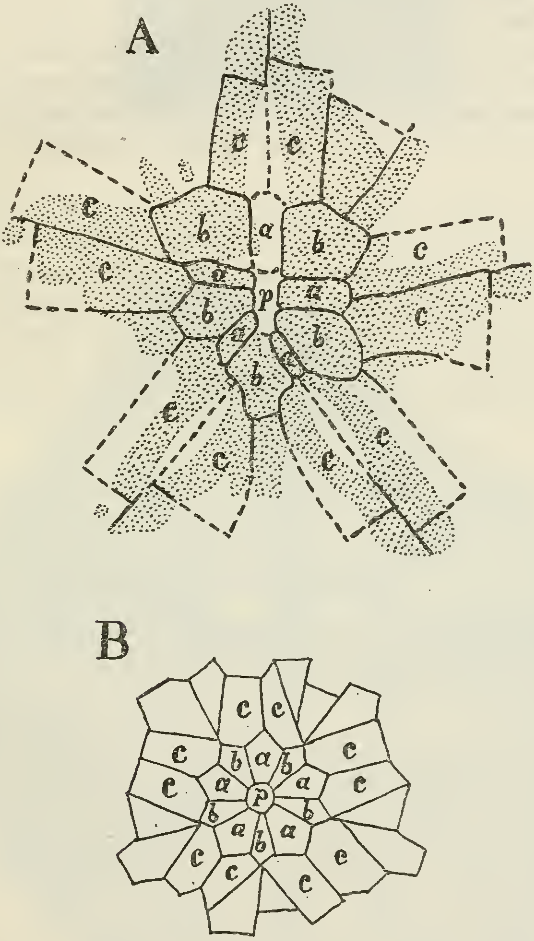


FIG. 2.—COMPARISON OF ARRANGEMENT OF PLATES OF (B) ACTINAL SIDE OF SCUTELLA SUBROTUNDATA LAMARCK WITH THAT OF (A) SCUTELLASTER CRETACEUS CRAGIN. THE LETTERS INDICATE THE EQUIVALENTS AS INTERPRETED BY THE WRITER. PERISTOME=*P*.

missing, and it is possible only to guess at their probable maximum length and breadth. The original surface of most of the plates is gone and in only a few small areas is anything suggesting the spines or tubercles present (see pl. 1, fig. 2). No part of the ambitus is preserved, and any statement as to the outline of a complete test is unfounded. To all appearances the outline of the specimen is as it was when originally found, and Cragin was probably unjusti-

fied in describing it shaped like *Clypeaster*. The test, however, clearly was broad and flat as in *Scutella*, and such of the plates of of the upper (abactinal) surface as can be made out do have a scutelliform arrangement. A hypothetical restoration of the abactinal surface, based on the specimen in hand and a Miocene *Scutella*, is shown in figure 1.

The petaloid areas and the central part of the test have been deeply excavated at some time and now disclose a group of peculiarly shaped plates which, however, may be matched closely with those of the undersurface of *Scutella*. A diagram comparing the arrangement of the plates with that of a Miocene *Scutella* is given in figure 2.

It seems to the writer probable that if better material is ever discovered this genus will be found very close to *Scutella*, if not identical with it. Inasmuch as only the single unsatisfactory specimen is now at hand, it seems best for the time being to leave the generic assignment as it was made by Cragin. The known Scutellidae are all Tertiary, and the present species if interpreted correctly would extend the range of the family into the Upper Cretaceous.

EXPLANATION OF PLATE

PLATE 1

Scutellaster cretaceus Cragin

FIG. 1. Type specimen, natural size. Photographs, retouched.
2. Area indicated by small rectangle on figure 1, enlarged 5 diameters. Photograph, retouched.

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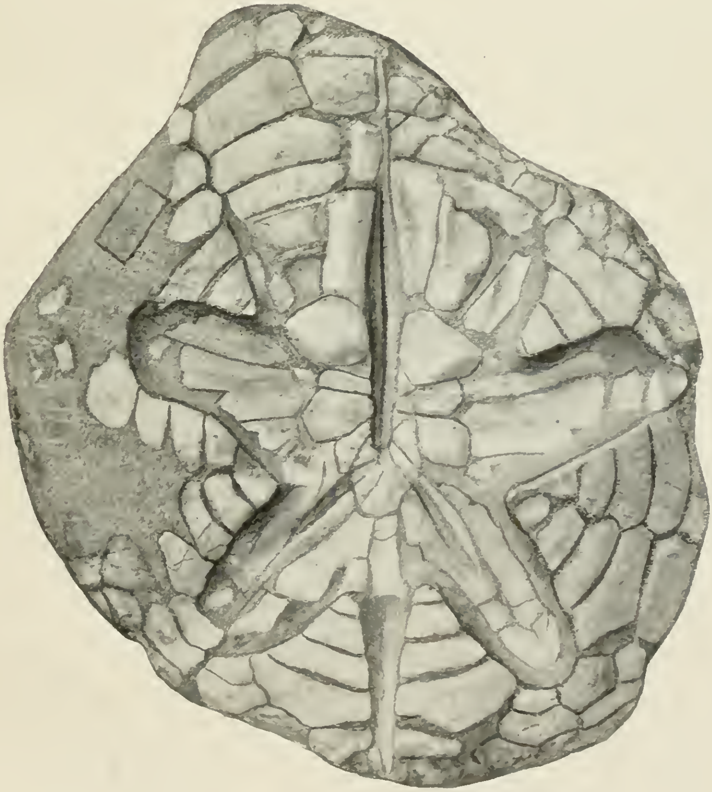

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SCUTELLASTER CRETACEUS CRAGIN

FOR EXPLANATION OF PLATE SEE PAGE 14

A PLEISTOCENE FLORA FROM THE ISLAND OF TRINIDAD

By Edward W. Berry,
Of the Johns Hopkins University, Baltimore, Maryland

The present contribution is based upon a considerable collection of fossil plants which I owe to the industry and kind cooperation of Dr. H. G. Kügler and the courtesy of the Apex Oilfields, Ltd., of Fyzabad, Trinidad. I am indebted for three additional specimens to Prof. Gilbert D. Harris. The latter were collected by G. A. Waring. The types have been presented to the United States National Museum.

Fossil leaves were reported from Trinidad in 1860 by Wall and Sawkins but no collections from the Island have been studied until recently. Doctor Kügler has made large collections for me which await description, and the New York Botanical Garden have also made collections which have been described by Dr. Arthur Hollick, whose account is now in press. All of these are from earlier beds than those which form the subject of the present paper.

This collection comes from strata known locally as the Oropouche formation, and comprise sands and horizontal, more or less lignitic, clays, that receive their name from outcrops near the village of Oropouche in the western half of the southern depression of the island. These sands and clays represent the erosion products of the folded areas of the central and southern ranges during the Pleistocene.

The collecton is of very great interest because, although the number of species is limited, they give clear evidence of the presence of mangrove swamps during the Pleistocene, and the fact that several of the forms cannot be positively identified with members of the existing flora of that region and have had to be described as new, and therefore extinct, indicates a considerable antiquity.

The species described number 9 and represent 7 orders and 8 families. With the exception of a single trace of a feather palm of

unknown genus, all are rather coriaceous dicotyledons. By far the most abundant leaves are those of the white mangrove and the *Mimusops*.

At least three of the forms—the buttonwood (*Conocarpus*), white mangrove (*Rhizophora*), and black mangrove (*Avicennia*)—are members of the mangrove association, and indicate more or less tidal muddy coastal swamps. These were in all probability estuary in position which is where they usually find their optimum conditions of growth. The *Mimusops*, which is described as new, finds its closest living homologies in forest species. This might be taken to mean that their leaves were river borne, but since they are the most abundant forms in the Oropouche clays it would seem that they must have been growing near at hand in the beach jungle behind the mangrove swamps or in the lower valley of the supposed stream that made the estuary. Such an environment would be the natural one for the other members of this flora.

All of the plants are lowland humid tropical types. All the existing species recorded as fossils occur in the existing flora of Trinidad and those which are described as extinct, have closely related existing species in Trinidad and the adjacent coastal region of South America.

Class MONOCOTYLEDONAE

Order ARECALES

Family ARECACEAE

PALM RAY

Plate 1, figs. 1, 2

The single basal part of the ray of a fan palm is the only representative of this class of plants found in the Oropouche clays.

These rays are linear lanceolate, markedly inequilateral proximad, where they are contracted to a petiolar-like attachment on the rachis. The venation appears to be characteristic, consisting of 8 principal regularly spaced longitudinal veins with 3 or 4 thinner parallel veins in each interspace.

It might be possible to connect the fossil with some recent Trinidad palm, but in view of the fragmentary nature of the fossil and the uncertainties involved, it did not seem worth the labor of searching through herbaria in which palms are usually so incompletely represented.

Type.—Cat. No. 37017, U. S. N. M.

Class DICOTYLEDONAE

Order ROSALES

Family MIMOSACEAE

Genus PITHECOLOBIUM Martius

PITHECOLOBIUM UNGUIS CATI (Linnaeus) Bentham

Plate 3, fig. 4

A single leaflet, identical with those of this existing species has been found in the Oropouche beds. There is no necessity to describe it in detail. It is much like the smaller obtuse leaflets of *Pithecolobium dulce* (Roxburg) Bentham, but more exactly matches many of the leaflets of *Pithecolobium unguis cati*, and I have no doubt represents the latter species.

Pithecolobium unguis cati, or the Cats claw, sometimes referred to the genus *Zygia* of Patrick Browne is a rather small slender tree of sea coasts found from the Florida keys through the Antilles to Trinidad, Venezuela, and Colombia.

Fossil species are not uncommon in the warmer parts of the Tertiary of the western hemisphere. There are two well marked species in the lower Eocene Wilcox group and a third in the Oligocene of southeastern North America. There is a Miocene species in Colombia and a second from the Dominican Republic. There are 3 Pliocene species recorded from Bolivia.

Plesiotype.—Cat. No. 37018, U. S. N. M.

Order PARIETALES

Family GUTTIFERAE

Genus CLUSIA Linnaeus

CLUSIA FOSSILIA, new species

Plate 3, fig. 3

Leaves of medium size, obovate in outline, coriaceous in texture and with entire margins. Length about 11 centimeters. Maximum width, about two-thirds of distance above the base, about 6 centimeters. The apex is broadly rounded and may even be very slightly retuse. The base is narrowly cuneate. The ascending margins are practically straight to the region of greatest width of the lamina where they curve around rather regularly without angular shoulders to the broad tip. The petiole is short and extremely stout. The midvein is characteristic of the genus, thin above, increasing rapidly

in size and prominence proximad, until at the base where it joins the petiole it is 3 millimeters in diameter. The secondaries are thin but well marked, closely spaced and ascending. They diverge from the midrib at angles of about 30 degrees, are relatively straight in their courses, although adjacent ones occasionally join on their way toward the margin, where their extremities are united by a looped marginal vein about 1 millimeter within the margin.

There cannot be the slightest doubt but that these leaves represent the genus *Clusia*, presenting as they do to the last detail the foliar characters of this genus. I have compared them with the leaves of all of the existing forms from equatorial America which are represented in the National Herbarium. There are 3 existing species in the Trindad flora whose leaves are extremely difficult to distinguish from the fossil. These are *Clusia martini* Sagot and *Clusia palmicida* L. C. Rich which are large trees of the forest (specimens from Balandra Bay), and the wide ranging *Clusia rosea* Linnaeus, a somewhat smaller tree of the rocky coasts, at least the specimens from Trindad are so labeled.

The foliar characters of these are very convergent. In general the leaves of *Cusia palmicida* are somewhat more elongated. I doubt if it is possible to certainly distinguish *Clusia rosea* and *Clusia martini* from the leaves alone. The fossil appears to be more nearly identical with latter than the former of these, but occasional leaves of the former are indistinguishable. This being the case the fossil form is described as *Clusia fossilia*, and it is suggested that it might very well represent the stock subsequently differentiated into the three living species mentioned above as recognized by modern systematists.

So far as I know this is the first fossil species of this interesting genus to be recognized, although I have a fine and much larger species from the later Miocene of Trinidad.

Holotype.—Cat. No. 37019, U. S. N. M.

Order THYMELEALES

Family LAURACEAE

Genus PERSEA Gaetner fils

PERSEA AMERICANA Miller

Plate 1, fig. 4

The single incomplete leaf figured is the only specimen of this species collected. It has the form and venation of various tropical species of *Phoebe* and *Persea* and appears to be identical with the leaves of the existing *Persea americana* Miller.

The genus has been present in equatorial America throughout the Tertiary and probably earlier. A very similar form occurs in the Miocene of Trinidad, and Engelhardt has described similar forms from the Miocene of Colombia.

Plesiotype.—Cat. No. 37020, U. S. N. M.

Order MYRTALES

Family COMBRETACEAE

Genus CONOCARPUS Linnaeus

CONOCARPUS ERECTUS Linnaeus

Plate 1, fig. 5

There is no necessity to present a detailed description of these leaves. I have seven specimens from the Oropouche beds all more or less broken or distorted, but clearly belonging to the existing species, with whose variations the agreement is exact.

The single existing species in several varieties is a widespread type of the mangrove association, as well as sandy shores on both coasts of Central and South America, extending northward through the Antilles to the Florida keys, and through the agency of ocean currents reaching Bermuda. It is also found on the west coast of Africa in Guinea and Senegambia.

The earliest apparent representative of the genus is a form from the Tuscaloosa formation of Alabama described as *Conocarpites formosus.*[1] A second fossil species is found in the coastal floras of the lower Eocene Wilcox group [2] and a third occurs in the upper Eocene Jackson group [3] in southeastern North America. A fruit compared with *Conocarpus* has been described by Menzel [4] from the lower Miocene of Europe.

Plesiotype.—Cat. No. 37021, U. S. N. M.

Family RHIZOPHORACEAE

Genus RHIZOPHORA Linnaeus

RHIZOPHORA MANGLE Linnaeus

Plate 2, figs. 2, 4

Leaves of the mangrove vie with those of *Mimusops* in the Oropouche clays, some scores having been collected. When fragmentary the two are distinguished with difficulty.

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[1] Berry, E. W., U. S. Geol. Survey Prof. Paper 112, p. 127, pl. 28, fig. 9, 1919.

[2] Berry, E. W., idem, 91, p. 325, pl. 95, figs. 1, 2, 1916.

[3] Berry, E. W., idem, 84, p. 147, pl. 29, figs. 4–7, 1914.

[4] Menzel, P., Beitr. Fl. Niederrhein Braunkohlenformation, p. 63, pl. 5, figs. 17–21, 1913.

These leaves show the characteristic form and venation of the recent leaves of the mangrove, from which they can not be differentiated.

On the whole the *Rhizophora* leaves may be distinguished from those of the associated *Mimusops* by their being less coriaceous, with slightly longer petioles, and by their regularity of form, being always at least pointed and never emarginate, and by their slightly more prominent venation. For the most part they are preserved as brownish impressions in the clays and not as black carbonaceous films as are the bulk of those referred to *Mimusops*. I have gone through all of the material of *Rhizophora mangle* in the National Herbarium and aside from minor individual variations the leaves are uniform in their characters, and never exhibit the peculiar variations shown in *Mimusops*.

In the modern flora this species ranges on muddy tidal shores from southern Florida and Bermuda through the Antilles and Central America to Brazil, and from lower California to Ecuador. It is the most specialized plant known for distribution by ocean currents.

The genus appears in the fossil record in the early upper Eocene in southeastern North America[5] and a second fossil species is known from the Miocene of Venezuela.[6] Two Oligocene-Miocene species have been recorded from southern Europe.

Plesiotypes.—Cat. Nos. 37022–3, U. S. N. M.

Order EBENALES

Family SAPOTACEAE

Genus MIMUSOPS Linnaeus

MIMUSOPS PREDUPLICATA, new species

Plate 2, figs. 1, 3, 5; plate 3, fig. 5; plate 4, figs. 2, 3 4

This is an exceedingly interesting species and vies with the leaves of the mangrove in its abundant representation in the Oropouche clays. A considerable number of leaves showing the variety and extremes of its mutations have been figured. In general the leaves are elliptical in outline, with broadly rounded, emarginate or retuse tips, and rounded slightly pointed or cuneate bases. The petiole is short and extremely stout. The margins may be evenly rounded but are very frequently emarginately incised into a greater or less number of

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[5] Berry, E. W., U. S. Geol. Survey Prof. Paper 84, p. 144, pl. 29, figs. 1, 2, 1914.
[6] Berry, E. W., Proc. U. S. Nat. Mus., vol. 59, p. 576, pl. 109, fig. 4, 1921.

rounded lobes of varying sizes. The midrib is stout but not especially prominent. The secondaries are thin, largely immersed in the coriaceous leaf substance; they diverge from the midrib at wide angles at irregular intervals, and are abruptly camptodrome at a considerable distance inside the margins. The size varies from narrow elliptical leaves 3.5 centimeters long by 1.7 centimeters in maximum width like that shown in figure 3 on plate 2, to similarly shaped leaves 8 centimeters long and 5 centimeters in maximum width; from obcordate leaves 2.1 centimeters long and 1.7 centimeters wide like that shown in figure 4 on plate 4 to similar leaves 4.5 centimeters long and 3.4 centimeters wide like that shown in figure 2 on plate 4. Finally we have the large irregular leaves like those shown on plate 2, figure 1, and plate 4, figure 3, variously lobed and retuse, and without a parallel outside the family Sapotaceae in so far as I know. The more regular leaves of this species are distinguished with difficulty from the associated leaves of *Rhizophora* but as I have remarked under the discussion of the latter they are more coriaceous with more obsolete venation and with different tips. The petiole is shorter and stouter. and appears in the fossil material as more or less ribbed.

I have been to the pains of examining all of the material of the Sapotaceae preserved in the National Herbarium in my effort to absolutely connect the fossil with an existing species. Outside the genus *Mimusops* the only species showing variations in form comparable with the fossil is *Sideroxylon elegans* DeCandolle of the Guianas, in which the leaves are uniformly smaller and the venation is somewhat more prominent. In the genus *Mimusops* the two most similar species seen are *Mimusops duplicata* Urban, a common Antillean forest tree, and *Mimusops balata schomburghii* Pierre from the lower Orinoco region. In the latter the leaves average relatively longer and narrower and have longer petioles. In the former exactly the same variations in outline are shown, but such variants are usually smaller than the fossil, although specimens with regular leaves may be larger. On the whole the fossil is closest to *Mimusops duplicata* and I have described it as a possibly extinct form under the name of *preduplicata*, indicating a relationship, which may really amount to specific identity were all the facts known.

The genus *Mimusops* is a prolific and common tropical type in both hemispheres, reaching northward to the Florida keys in this hemisphere. In the fossil record it contains 3 lower Eocene species in southeastern North America and a fourth in the Miocene of Haiti. Several European species have been recorded, two coming from the late Eocene of Hesse.

Cotypes.—Cat. Nos. 37024–37030, U. S. N. M.

Order PERSONALES

Family VERBENACEAE

Genus AVICENNIA Linnaeus

AVICENNIA NITIDA Jacquin

Plate 3, figs. 1, 2, 6; plate 4, fig. 1

Leaves of the black mangrove of various sizes are common in the Oropouche clays. These agree perfectly with the leaves of the existing species, from which they can not be differentiated. In the modern flora the species is a widely distributed maritime form ranging from peninsular Florida through the Antilles to Brazil.

The only other fossil occurrence known to me is based upon leaves and fruits found in the lower Eocene Wilcox formation of southeastern North America.[7]

Plesiotypes.—Cat. Nos. 37031–33, U. S. N. M.

INCERTAE SEDIS

PHYLLITES OROPOUCHENSIS, new species

Plate 1, fig. 3

The present nominal species is based upon two specimens in which the carbonaceous film representing the leaf is more or less impregnated with salts of iron. These represent an oblong ovate leaf with a bluntly pointed tip and a cuneate base. The texture is coriaceous and the midvein very stout. The secondaries are thin, numerous, and subparallel, diverging from the midvein at a rather wide angle and running with but slight curvature toward the margins. Their endings or other details of the venation cannot be made out and it is therefore impossible to reach a decision as to whether the fossil should be referred to the Guttiferae or the Sapotaceae. It appears to be certainly referable to one or the other of these families and is particular suggestive of certain Caribbean species of the genera *Rheedia*, *Calophyllum*, and *Chrysophyllum*, to one or the other of which it, in all probability, belongs. Doubtless future collections will settle this point.

Holotype.—Cat. No. 37034, U. S. N. M.

EXPLANATION OF PLATES

PLATE 1

FIGS. 1, 2. Palm ray. Fig. 2 enlarged ×4 to show venation.
3. *Phyllites oropouchensis*, new species.
4. *Persea americana* Miller
5. *Conocarpus erectus* Linnaeus.

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[7] Berry, E. W., U. S. Geol. Survey Prof. Paper 91, p. 347, pl. 104, fig. 6; pl. 107, fig. 4, 1916.

PLATE 2

FIGS. 1, 3, 5. *Mimusops preduplicata*, new species.
2, 4. *Rhizophora mangle* Linnaeus.

PLATE 3

FIGS. 1, 2, 6. *Avicennia nitida* Jacquin
1. Recent leaf. 2, 6. Fossil leaves.
3. *Clusia fossilia*, new species.
4. *Pithecolobium unguis cati* (Linnaeus) Bentham.
5. *Mimusops preduplicata*, new species.

PLATE 4

FIGS. 1. *Avicennia nitida* Jacquin
2–4. *Mimusops preduplicata*, new species.

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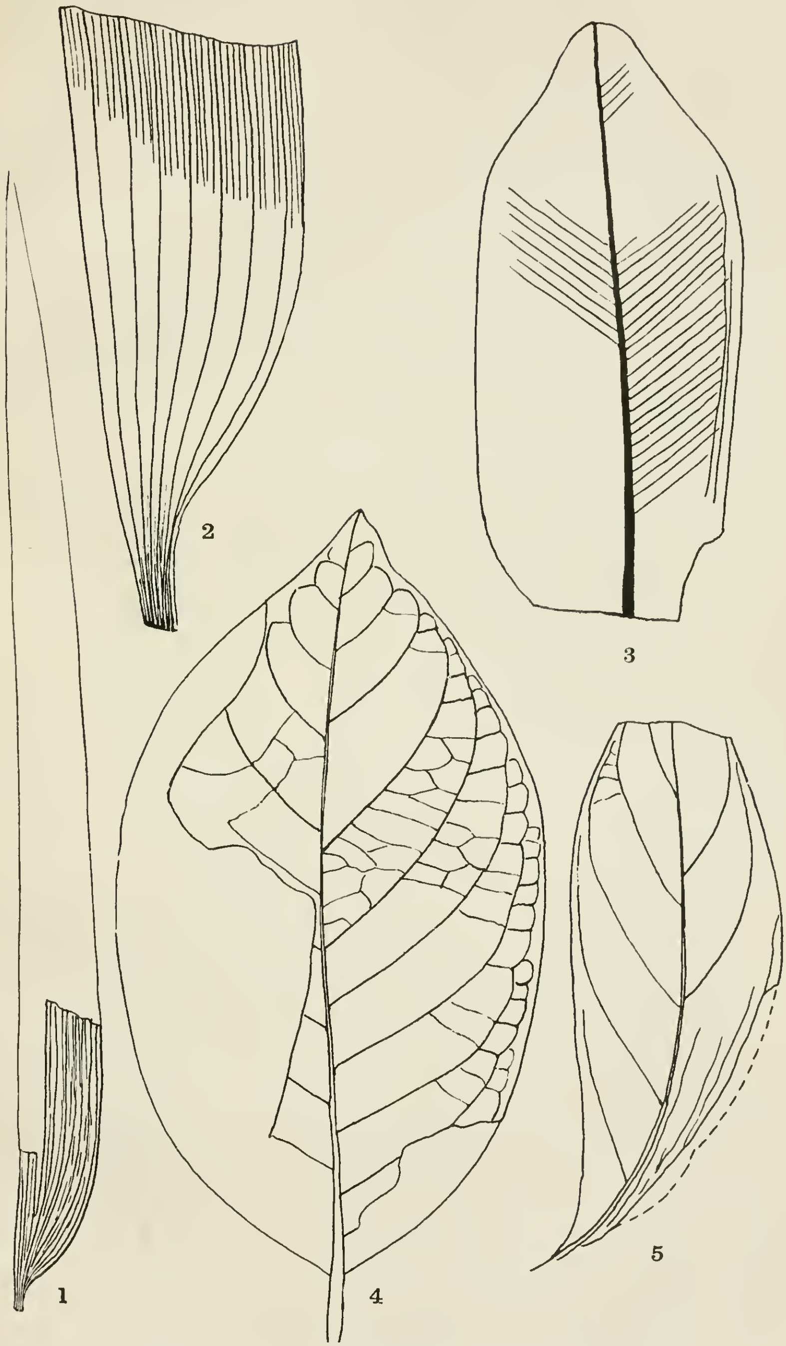
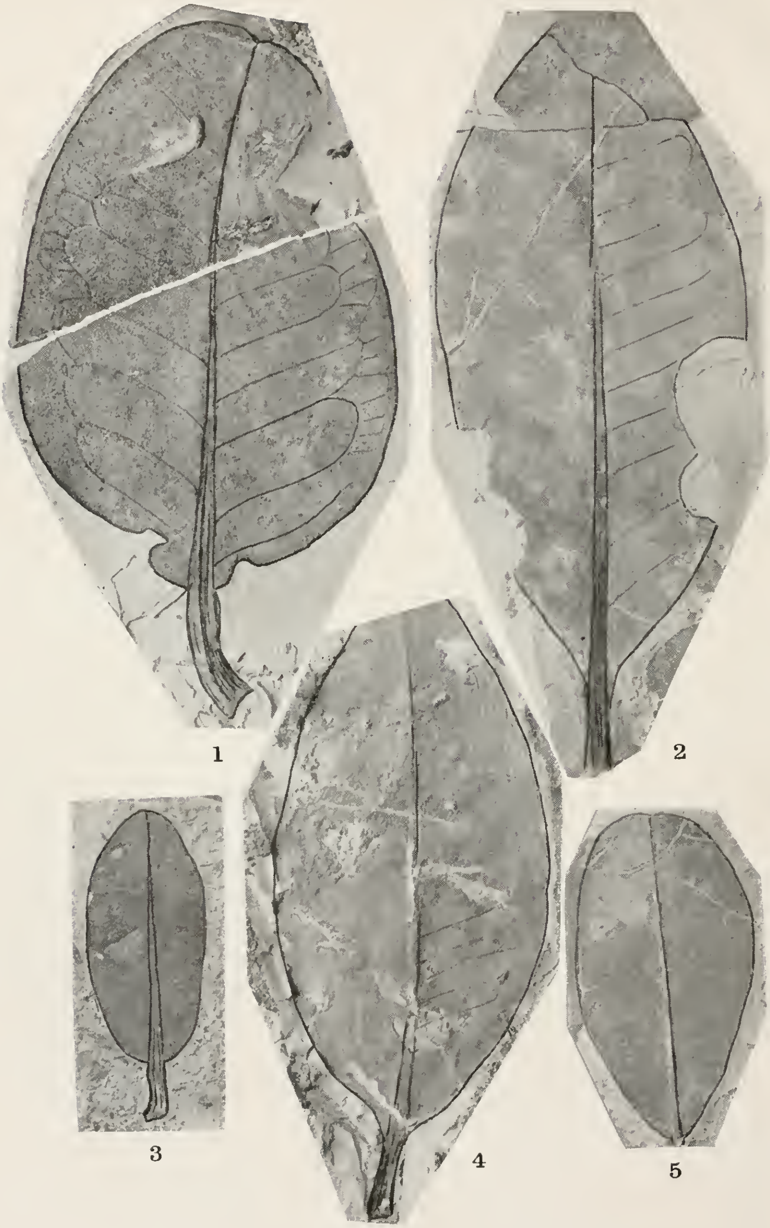


PLEISTOCENE FLORA FROM THE ISLAND OF TRINIDAD

FOR EXPLANATION OF PLATE SEE PAGE 8

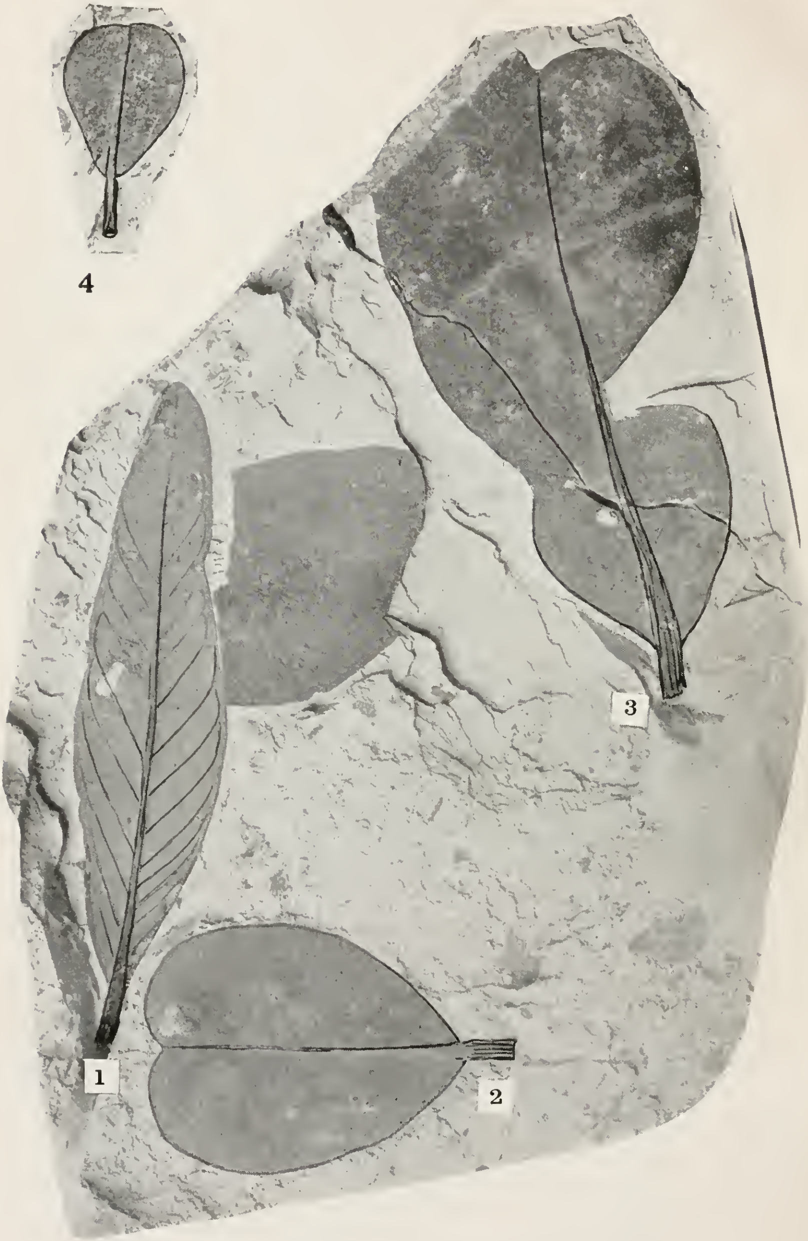


Pleistocene Flora from the Island of Trinidad

For explanation of plate see page 9

PLEISTOCENE FLORA FROM THE ISLAND OF TRINIDAD

FOR EXPLANATION OF PLATE SEE PAGE 9



PLEISTOCENE FLORA FROM THE ISLAND OF TRINIDAD

FOR EXPLANATION OF PLATE SEE PAGE 9

MIOCENE GASTROPODS AND SCAPHOPODS FROM TRINIDAD, BRITISH WEST INDIES[1]

By Wendell C. Mansfield
Of the United States Geological Survey

INTRODUCTION

The object of this paper is to describe some inadequately known Miocene gastropods and scaphopods from a few localities in Trinidad, British West Indies, and to determine, in so far as practicable, their stratigraphic position with respect to the standard section of the Atlantic and Gulf Coastal Plain and the West Indies.

PRINCIPAL PUBLICATIONS ON THE GEOLOGY AND PALEONTOLOGY OF TRINIDAD

Wall, G. P., and Sawkins, J. G., Report on the Geology of Trinidad: London, 1860.

In the treatise on the descriptive geology the rocks are separated into three groups—Caribbean group, the Older Parian group, and the Newer Parian group. The Newer Parian group is again separated into five divisions or series, arranged in stratigraphic age sequence from the lowest up as follows: Nariva series, Naparima marl, Tamana or calcareous series, Caroni or Carbonaceous series, and Moruga or arenaceous series. The age of the Caribbean group is uncertain but is regarded as antedating the Older Parian; the Older Parian is tentatively assigned to the Lower Cretaceous; and the Newer Parian is questionably assigned to the Miocene. The geologic map accompanying the report is the only one now available.

Although some of the results outlined are not conclusive, the report is an admirable example of scientific work on pioneer geology in an area beset with many difficulties.

Guppy, R. J., Lechmere and Dall, W. H., Descriptions of Tertiary fossils from the Antillean region: U. S. Nat. Mus. Proc., vol. 19, No. 1110, pp. 303–331, 4 pls., 1896. In this publication fifteen new species of mollusks are described by Guppy from Trinidad.

Guppy was intensely interested in the geology of Trinidad as well as other areas, and his contributions to both paleontology and stratigraphy are a val-

[1] Dr. Carlotta Joaquina Maury's paper "A further contribution to the Paleontology of Trinidad" (Miocene horizons), published as Bulletin 42 of American Paleontology, volume 10, appeared while my paper was in corrected page-proof form and in the hands of the editor; consequently the page proof was recalled and necessary revisions made.

The principal revisions consisted in the substitution of nine names of Doctor Maury's species for the names of the same forms which I had described as new, but retained my own descriptions. References to her descriptions were inserted in the synonymy.

The "Outline of results" in my paper was not changed. In this connection, however, Doctor Maury has placed in the lower Miocene the fauna at Brasso Creek, which I infer is the locality represented by my station numbers 8302 and 9212, and at Guaica-Tamana Road, thirteenth milepost, which appears to be the locality represented by my station 9219; the former she referred to the Manzanilla Miocene and the latter to the stratigraphically lower Machapoorie Miocene. Doctor Maury's interpretation of the age of the faunas, based on her study of both the gastropods and the pelecypods, suggests to me a stronger probability that the fauna at my station 9219, and perhaps some of the possibly mixed faunas from the stream wash 1 mile south of Brasso, belong to the lower Miocene, though I regard the fauna at station 9219 as a little higher stratigraphically than that at Machapoorie Quarry.

uable asset to geology. For about half a century he investigated and reported upon the fossil faunas of Trinidad, Tobago, Antigua, Jamaica, and other Antillean islands. In this paper references pertinent to the text are made to some of his publications. Dr. G. D. Harris[2] has published a reprint of Guppy's more inaccessible paleontogical writings.

MAURY, C. J., A contribution to the Paleontology of Trinidad: Acad. Nat. Sci., Phila. Journ., vol. 15, 2d ser., pp. 23–112, 9 pls., 1912.

"The specimens were collected from Tertiary beds at Brighton, on the Island of Trinidad, and from the small outlying islets, Soldado and Farallon Rocks. A few are also included from Cretaceous shales and Pleistocene raised beaches, both on the opposite Venezuelan mainland."

None of the species occurring in the above deposits were found in the material examined for my report.

A number of other writers have contributed valuable information to the geology and paleontology of Trinidad, and their names should be included in a complete bibliography.

Fossils studied.—Most of the fossils studied were collected by F. W. Penny and J. A. Bullbrook. The localities of the fossil collections are distributed through the east and west-central part of the island in a narrow area on the north slope of the Central Mountain Range. The gastropod fauna is meager from all localities except that obtained from a flood-wash in the vicinity of Brasso.

Many of Guppy's type specimens from Trinidad are deposited in the United States National Museum and were found useful for comparison.

Outline of results.—As the molluscan fauna is poorly represented in most instances, the study of the other organisms and a knowledge of the field relations of these faunal deposits are essential to accurately construct the local stratigraphic column and to correlate its units with outside deposits.

For this reason I have only tentatively assigned the groups of fossils to positions in the stratigraphic column. I have endeavored, when possible, to determine the nearest relative of the species studied in outside deposits.

A general outline of results is about as follows:

All the faunas considered in this paper are believed to be Miocene.

The fauna at station 8301, Machapoorie Quarry, and at station 8299, Cumuto Road, 17 miles, is believed to be the oldest and is referred to the lower Miocene.

The fauna collected from the flood-wash in the vicinity of Brasso is very similar to that at station 9219, Guaico-Tamana Road, 2 chains east of mile 13, is stratigraphically higher than that at Machapoorie Quarry, and is tentatively referred either to the upper part of the lower Miocene or to the lower part of the middle Miocene.

The bed from which the specimens collected on the Manzanillan coast were obtained is not stated on the labels, but certain species indicate a middle Miocene age rather than older.

[2] Harris, G. D., Bull. Amer. Paleont., vol. 8, pp. 149–346, 1921.

The fauna at Springvale is believed to be much younger than that in the Brasso beds and is assigned to the upper Miocene.

LIST OF LOCALITIES AND FOSSILS

LOWER MIOCENE

List of stations

8299. (Loc. 3) Caroni County, San Rafael Ward, Cumuto Road, 17 miles from the Eastern Main Road (61° 13′ 25″ W.; 10° 28′ 30″ N.). F. W. Penny, collector.

8301. (Loc. 5) Nariva County, Charuma Ward, Machapoorie Quarry (61° 14′ 35″ W.; 10° 27′ 25″ N.). F. W. Penny and J. A. Bullbrook, collectors.

The gastropod fauna at the above two stations shows close relationship and is believed to be the oldest fauna studied, the age of which strongly indicates lower Miocene.

Turritella machapoorensis Maury, is closely related to *T. tampae;* and *T. caparonis* Maury, is closely related to *T. chipolana*. *Amauropsis trinitatensis*, new species, resembles an Anguilla form; *Modulus tamanensis* Maury (a much larger form also occurs at station 9219) is related to *M. wilcoxii*, a Chipola species.

Faunal list

	Stations		Remarks
	8299	8301; 9220	
Cypraea trinitatensis, new species	×		
Modulus tamanensis Maury		×	Closely related to *M. wilcoxii* Dall (Chipola). Also at sta. 9219.
Turritella machapoorensis Maury	×	×	Aff. *T. tampae* Heilprin (The "silex beds" of the Tampa formation, Florida).
Turritella caparonis Maury		×	Aff. *T. chipolana* Dall.
Turritella aff. *T. perattenuata praecellens* Pilsbry and Brown.		×	
Amauropsis trinitatensis, new species	×		Resembles an undescribed form from Anguilla.
Calliostoma attrina, new species	×		
Liotia machapooriensis, new species		×	
Mostly poorly preserved specimens			
Conus, species		×	
Ancilla, species		×	
Clava, species		×	
Cerithium, 2 species		×	
Serpulorbis, species		×	
Natica, species		×	
Sinum, species		×	
Eunaticina, species		×	
Dentalium, species		×	

MIDDLE OR LOWER MIOCENE

List of stations

9027. Caroni County, Montserrat Ward, Brasso-Gran Couva Road, 100–200 yards west of Brasso. Fossiliferous clay immediately overlying *Turritella*-bearing limestone. J. A. Bullbrook, collector.

9196. Caroni County, Montserrat Ward, junction of Gran Couva and Brasso-Tabaquite roads. J. A. Bullbrook, collector.

9215. Caroni County, Montserrat Ward, Brasso railway station. Steam wash. J. A. Bullbrook, collector.

8302. (Loc. 6.) Caroni County, Montserrat Ward, 1 mile south of Brasso railway station (61° 19′ 18″ W.; 10° 23′ 45″ N.). Flood-wash from stream bank. F. W. Penny, collector.

9212. About one mile south of Brasso. Flood-wash from stream. J. A. Bullbrook, collector. (Same locality as 8302 but later collection.)

9219. St. Andrew County, Turure Ward, Guaico-Tamana Road, 2 chains east of mile 13 from junction with Eastern Main Road at Guaico railway station. Brasso clays. J. A. Bullbrook, collector.

8300. (Loc. 4.) Caroni County, San Rafael Ward. Four Roads Quarry (61° 12′ 55″ W.; 10° 28′ 55″ N.). F. W. Penny, collector. Also a later collection from the same quarry obtained by J. A. Bullbrook.

Faunal list

	Stations							Remarks
	9027	9212	8302	9215	9219	8300	9196	
Mollusca:								
Ringicula aff. *R. tridentata* Guppy.	×	----	----	----	----	----	----	
Terebra (*Strioterebra*) *trinitatensis*, new species.	----	×	----	----	----	----	----	
Terebra (*Strioterebra*) *brassoensis*, new species.	----	×	----	----	----	----	----	
Conus trinitatensis, new species	----	----	----	----	×	----	----	Somewhat similar to a Shoal River, Fla., form.
Conus multiliratus walli, new subspecies.	----	×	----	----	×	----	----	*C. multiliratus* more characteristic of middle Miocene.
Turris brassoensis, new species	----	×	×	----	----	----	----	Similar to a new species from the Shoal River marl member of the Alum Bluff formation.
Turris vaningeni var. *machapoorensis* (Maury).	----	----	----	----	×	----	----	
Drillia consors bullbrooki, new subspecies.	----	----	----	----	×	----	----	Apparently occurs in Baitoa formation, Dominican Republic.
Drillia consors trinitatensis, new subspecies.	----	×	----	----	----	----	----	Very similar to *Pleurotoma alisedota* var. *magna* Böse.
Drillia pennyi, new species	----	×	×	----	----	----	----	
Drillia pennyi acaria, new subspecies.	----	×	----	----	----	----	----	
Drillia tridadina, new species	----	×	×	----	----	----	----	
Drillia daditrina, new species	----	×	----	----	----	----	----	Somewhat similar to *D. senaria* Woodring (Ms.) Bowden.
Drillia propefusiformis, new species.	----	----	----	----	×	----	----	Aff. *D. fusiformis* (Gabb) from Gurabo formation, Dominican Republic.
Drillia inniadda, new species	----	×	×	----	----	----	----	
Drillia nitrina, new species	----	×	----	----	----	----	----	
Drillia niaddrina, new species	----	×	----	----	----	----	----	
Drillia inadrino, new species	----	×	×	----	----	----	----	
Glyphostoma caronensis, new species.	----	×	----	----	----	----	----	
Glyphostoma (?) *triniada*, new species.	----	×	----	----	----	----	----	
Glyphostoma amicta rintriada, new subspecies.	----	----	×	----	----	----	----	*Glyphostoma amicta* (Guppy) is a Bowden species.
Glyphostoma (?) *addrina*, new species.	----	×	×	----	----	----	----	
Microdrillia trina, new species	----	×	----	----	----	----	----	Similar to a form from Monkey Hill, Panama, and to a Chipola species.
Microdrillia propetrina, new species.	----	----	×	----	----	----	----	
Borsonia (*Paraborsonia*) *brassoēnsis*, new species.	----	×	----	----	----	----	----	Similar to *Borsonia varicosa* (Sowerby).
Cancellaria bullbrooki, new species.	----	----	----	----	×	----	----	
Ancilla paralamellata, new species.	----	×	----	----	----	----	----	
Ancilla brassica Maury	----	----	----	----	×	----	----	
Marginella (*Faba*) *bullbrooki*, new species.	----	×	×	----	----	----	----	
Marginella (*Faba*) *brassoensis*, new species.	?	×	×	----	----	----	----	
Marginella guaica Maury	----	×	----	----	×	----	----	Resembles *M. sowerbyi* Gabb from Cercado and Gurabo formations, Dominican Republic.
Marginella solitaria montserratensis, new subspecies.	----	----	×	----	----	----	----	*M. solitaria* Guppy is from Point-à-Pierre.
Marginella (*Closia*) *nitrina*, new species	----	----	×	----	----	----	----	Resembles *M. ovuliformis* Orbigny, Pliocene to Recent.

Faunal list—Continued

	Stations							Remarks
	9027	9212	8302	9215	9219	8300	9196	
Mollusca—Continued.								
Marginella (*Gibberula*) *trinitatensis*, new species.	----	×	----	----	----	----	----	Somewhat resembles *M. cercadensis* Maury, Cercado.
Vexillum bristoli (Maury)	----	×	----	----	----	----	----	Aff. *Vexillum tortuosellum* (P. & J.) from Dominican Republic.
Phos bullbrooki, new species	----	----	----	----	×	----	----	
Phos trinitatensis, new species	----	×	----	----	×	----	----	Very close to 5883e near basal section at Bananito River, Costa Rica.
Alectrion brassoënsis, new species	----	×	×	----	----	----	----	Aff. *A. cercadensis* Maury, Cercado formation.
Metulella caronensis, new species	----	×	----	----	----	----	----	Resembles *S. costaricensis* Olsson from Gatun formation.
Strombina walli, new species	----	×	×	----	----	----	----	Resembles *S. chiriquiensis* Olsson, Gatun formation, also *S. pseudohaitensis* Maury, Cercado formation.
Typhis sawkinsi, new species	----	----	----	----	×	----	----	Recalls *T. gabbi* B. & P., Gatun, Panama.
Modulus tamanensis Maury	----	----	----	----	×	----	----	Closely related to *M. wilcoxii* Dall, Chipola.
Caecum properegulare, new species	----	----	×	----	----	----	----	Closely resembles a form from Shoal River, Fla.
Turritella gatunensis caronensis, new subspecies.	----	×	×	×	----	----	----	*T. gatunensis* referred to Gatun formation, Panama and Costa Rica
Turritella sp. aff. *T. altilira* var. *chiriquiensis* Olsson.	----	×	×	×	×	----	----	Reported by Olsson from Gatun formation in Panama and Costa Rica.
Turritella montserratensis, new species.	----	----	----	----	----	----	×	Resembles *T. altilira costaricensis* Olsson, Gatun.
Turritella cf. T. altilira Conrad (typical).	----	×	----	(?)	----	×	----	
Natica canrena (Linnaeus)	×	----	×	----	×	----	×	
Calliostoma rhombotum, new species.	----	×	----	----	----	----	----	
Teinostoma caronensis, new species.	×	----	----	----	----	----	----	
Adeorbis guppyi, new species	----	×	----	----	----	----	----	
Cadulus caronensis, new species	----	×	×	----	----	----	----	Recalls an Eocene sp. *C. abruptus* Meyer and Aldrich.
Dentalium cossmannianum Pilsbry and Sharp?	----	----	×	----	----	----	----	
Genera either poorly preserved or require a specialized study to determine their specific relationship								
Olivella, 2 species (yo.)	----	×	×	----	----	----	----	
Mitra, species (yo.)	----	×	----	----	×	----	----	
Strombina, species (yo.)	----	----	×	----	----	----	----	
Strombina, species (frag.)	----	×	----	----	----	----	----	
Typhis, species (frag.)	----	×	×	×	×	----	----	
Epitonium, species (yo.)	----	----	×	----	----	----	----	
Acrilla, species (frag.)	----	----	×	----	----	----	----	
Melanella, species	----	----	×	----	----	----	----	
Turbonilla, several species	----	----	×	----	----	----	----	
Pyramidella, several species	----	----	×	----	----	----	----	
Odostomia, species	----	----	×	----	----	----	----	
Strombus (frag.)	----	----	----	----	×	----	----	
Cerithium, species	----	----	----	----	----	×	----	
Clava, species (yo.)	----	×	----	----	----	----	----	
Bittium, 2 species	----	×	----	----	----	----	----	
Serpulorbis, species (frag.)	----	×	----	----	----	----	----	
Rissoina, species	----	×	----	----	----	----	----	
Calyptraea, species	----	×	----	----	----	----	----	
Architectonica, species (yo.)	----	×	×	----	----	----	----	
Bryozoa [1]	----	----	----	----	----	----	----	
Cupularia umbellata Defrance	----	×	----	----	×	----	----	
Cupuladria canariensis Busk	----	×	----	----	----	----	----	
Crustacea [2]	----	----	----	----	----	----	----	
Callinectes, species	----	×	----	----	----	----	----	
Thaumastoplax prima Rathbun	----	----	----	×	----	----	----	Described from station 6020*a*. Lower part of the upper half of Culebra formation, Panama.

[1] Identified by Dr. Ray Bassler, of the U. S. National Museum.

[2] Identified by Dr. Mary J. Rathbun, of the U. S. National Museum.

The fauna listed above at stations 9027, 9196, and 8300 is represented by only a few species and its relationship to the larger fauna at the other stations is uncertain. That at 9027 and 9196 indicates a little higher stratigraphic position. About one-half the species at station 9219 are represented in the collection from the flood-wash near Brasso—stations 8302, 9212, and 9215—and its fauna indicates the same stratigraphic horizon to some part if not the whole of these beds. The material from the flood-wash may represent the assemblage of species from more than one stratum or perhaps horizon. Some of the species from station 9219 and from the flood-wash at Brasso indicate a horizon a little lower stratigraphically than that of the Bowden marl of Jamaica or that of the Gurabo formation of the Dominican Republic, but others are closely related to species in those formations. Consequently this fauna may have lived either during the latter part of the lower Miocene or the early part of the middle Miocene.

The following species apparently show a close relationship to the Bowden and Gurabo formations—now referred to the middle Miocene:

Conus multiliratus, subspecies *walli*, new subspecies. *Conus multiliratus* is more characteristic of the middle Miocene.

Drillia propefusiformis, new species.

Glyphostoma amicta rintriada, new subspecies. *Glyphostoma amicta* is a Bowden species.

Phos trinitatenses, new species. In Costa Rica a very similar form is found in a fauna carrying *Sconsia laevigata*.

Species related to species now referred to the lower Miocene are:

Turris brassoensis, new species—very close to a species in the Shoal River marl member of the Alum Bluff formation, Florida.

Drillia consors bullbrooki, new subspecies. Apparently the same form occurs in the Baitoa formation, D. R.

Microdrillia trina, new species. Related to a Chipola species.

Marginella trinitatensis, new species. Resembles *M. cercadensis* Maury, Cercado formation.

Vexillum bristoli (Maury). Related to a Chipola species.

Alectrion brassoensis, new species. Aff. *A. cercadensis* Maury, Cercado formation, D. R.

Strombina walli, new species. Resembles pseudohaitensis Maury from Cercado formation.

Modulus tamanensis Maury. Aff. *M. wilcoxii* Dall from the Chipola marl member of the Alum Bluff formation. Also occurs at Machapoorie Quarry.

Thaumastoplax prima Rathbun. Type from Culebra formation, Panama.

FAUNA FROM MANZANILLA COAST

Station and faunal list

9197. St. Andrew County, Manzanilla Ward, Manzanilla Coast. J. A. Bullbrook, collector. (The matrix adhering to the specimens is indicated as follows: (*a*) ferruginous matrix; (*b*) gray sandy matrix; (*c*) indurated gray matrix.)

a. *Conus manzanillaënsis*, new species. Resembles in a general way an unpublished species from the Baitoa and Cercado formation, D. R., but with a different type of nucleus.

c. *Turricula* (?), *species*, indeterminable. In a general way, resembles *Surcula vicksburgensis* Casey (Oligocene).

c. *Drillia manzanillaensis*, new species.

a. *Ancilla lamellata* (Guppy).

c. *Marginella guppyana*, new species.

b. (?) *Alectrion brassoënsis*, new species.

Bryozoa.

Microporella, species.

Guppy's types from Manzanilla not in the above list:

Cylichnella ovum-lacerti (Guppy).

a. *Leda guppyi* Dall (*Cercomya ledaeformis* Guppy) aff. *L. dalliana* Olsson. Gatun formation, Port Limon. A closely allied form occurs at Brasso (9212).

a. *Leda illecta* Guppy, aff. *L. Guppyi* but with finer concentric sculpture.

b. *Arca trinitaria* Guppy. Group of *A. macdonaldi* Dall, Gatun.

b. *Arca filicata* Guppy. Group of *A. pittieri* Dall, Gatun.

a. *Cardium castum* Guppy. Badly eroded specimens. Perhaps nearer to a Bowden form.

Dosinia cyclica Guppy. A Lucinopsis according to Dall (U.S.N.M. Proc., vol. 19, p. 329, 1896). Specimen not seen.

a. *Venus walli* Guppy. (A Chione), aff. *C. chipolana* Dall, from Chipola marl member of Alum Bluff formation.

a. *Corbula vieta* Guppy. Close to *C. heterogenea* Dall. A Bowden species.

a. *Erycina tensa* Guppy—probably the left valve of *Corbula vieta* Guppy.

a. *Mactrinula macescens* Guppy=*Mactra* (*Mactrotoma*). Closely related to *Mactra* (*Mactrotoma*) *cymata* Dall from the Oak Grove sand member of Alum Bluff formation.

The matrix adhering to the specimens indicates that they came from several different beds. Wall and Sawkins[3] in their detailed sections—sheet 2, figure 1—show different fossiliferous beds along the coast above Manzanilla Point. I do not know the stratigraphic position of the fossils listed from Manzanilla coast. *Arca trinitaria* Guppy and *Arca filicata* Guppy are closely related to species probably of middle Miocene age in Costa Rica. It appears highly probable that some of the beds in this area are of middle Miocene age.

UPPER MIOCENE

List of stations

9195. Caroni County, Couva Ward, Springvale, near Couva, Mount Pleasant Road, about ¾ to 1 mile south of Milton. J. A. Bullbrook, collector.

9224. Caroni County, Couva Ward, Springvale, same locality as 9195 but later collection. J. A. Bullbrook, collector.

[3] Report on the Geology of Trinidad, 1860.

Faunal list

	9195	9224	
Mollusca:			
Conus springvalcēnis, new species	×	------	Resembles *C. chipolanus* Dall in a general way.
Turricula springvaleēnsis, new species	×	------	Suggests *T. lavinoides* Olsson, Gatun formation, Banana River, Costa Rica.
Drillia aff. *D. riogurabonis* Maury	------	×	
Oliva cylindrica Sowerby	×	------	
Pseudoliva guppyi, new species	------	×	
Cancellaria springvaleēnsis, new species	×	------	Resembles an unpublished form from the Chipola marl member of Alum Bluff formation of Florida.
Ancilla caroniana Maury	×	------	
Ancilla caroniana springvalensis, new subspecies.	×	------	
Marginella springvalcnsis Maury	×	------	Recalls *M. aurora* Dall-Chipola marl.
Marginella calypsonis Maury	×	------	Similar to *M. macdonaldi* Dall, Miocene, Costa Rica, and *M. cincta*, a Recent species.
Marginella (*Closia*) *lachrimula* Gould?	------	×	The species reported, Miocene to Recent.
Marginella (*Persicula*) *propeobesa*, new species.	×	------	
Mitra longa var. *couvensis* Maury	×	------	
Solenosteira semiglobosa Guppy	×	------	Closer related to a Miocene than Recent species.
Turbonilla, species	------	×	
Bittium, species	------	×	
Vermicularia, species	×	×	Resembles a Recent species of the West coast.
Petaloconchus alcimus, new species	×	------	
Turritella planigyrata Guppy	×	------	
Natica youngi Maury	×	------	
Natica canrena (Linnaeus)	×	------	
Fissuridea, species	------	×	
Described from Springvale:			
Capulus efluens Guppy (not figured)	------	------	Specimen not seen.
Solenosteira cochlearis Guppy	------	------	Do.
Raeta meridionalis Guppy	------	------	Do.
Bryozoa [1]			
Cupularia umbellata Defrance	------	×	
Cupuladria canariensis Bush	------	×	
Acanthodesia savartii Savigny	------	×	
Hemiseptella, species	×	------	
Terebripora, species	×	------	
Aimulosa, species	×	------	

[1] Identified by Dr. Ray Bassler, of the U. S. National Museum.

The fauna from Springvale is tentatively referred to the upper Miocene. This fauna is of special interest because it contains certain species that indicate a closer relationship to the Recent fauna of the Pacific side than to the Atlantic. The two forms especially noted among the gastropods that indicate this relationship are *Turritella planigyrata*, a species analogous to *Turritella broderipiana* Orbigñy; and *Vermicularia*, species, a form analogous to *Vermicularia eburneus* Reeve. Not only do the gastropods indicate this analogy but the pelecypods as well.

Only one of the species in my list from Springvale occurs in the list from Brasso. Guppy [4] records the species occurring at Springvale, illustrates by diagram the general relation of the stratum carrying this fauna to the other beds, and gives a brief discussion of the faunal characteristics. He assigns the fauna collected at Springvale to the Miocene.

[4] Fossils from Springvale, near Couva, Second Report Agr. Soc. Trinidad and Tobago. (Society Paper No. 454). 1911.

DESCRIPTIONS OF SPECIES

Class GASTROPODA

Genus CYLICHNELLA Gabb

CYLICHNELLA OVUM-LACERTI (Guppy)

Plate 1, figs. 7, 9

Cylichna ovum-lacerti GUPPY, Sci. Assoc. Trinidad Proc., vol. 1, pt. 3, p. 168, 1867, (Described).

Cylichna ovum-lacerti GUPPY, Geol. Mag., vol. 1, p. 407, pl. 18, fig. 22, 1874.

Törnatina (*Cylichnella*) *ovum-lacerti* GUPPY, Dall. U. S. Nat. Mus. Proc., vol. 18, p. 27, 1896.

Not *Cylichnella ovum-lacerti* (Guppy), PILSBRY, Acad. Nat. Sci. Phila. Proc., pt. 2, p. 311, text-fig. 7, 1921.

"Shell small, cylindrical-subovate, minutely striate transversely; spire small, sunken; aperture as long as the shell, dilated anteriorly; outer lip straight, blunt; columella callus with a strong tortuous fold."

"Lower Miocene, Manzanilla." (Guppy, 1867). U. S. Nat. Mus. Cat. No. 115435.

The shell of this species possesses a more cylindrical outline, a greater median compression than the form figured by Pilsbry,[5] or specimens in the United States National Museum collection from the Dominican Republic. However, it is quite similar.

Genus RINGICULA Deshayes

RINGICULA, species indeterminable

Ringicula, doubtful species, junior, DALL, U. S. Nat. Mus. Proc., vol. 19, p. 305, 1896.

The following is an original description of this doubtful species:

"Oblong-ovate, turrited; whorls five, spirally ribbed by rounded costae with narrow (linear) interstices; aperture suboval; columella with two strongly twisted folds; spire conic; apex smooth, blunt. Length 3 mm., breadth 2 mm." [G.]

"Ditrupa bed, Pointapier, Trinidad, Guppy (2270). No. 107108, U.S.N.M. Shells all incomplete and too young to name or discriminate, but useful as establishing the presence of this genus in the beds" [Dall], 1896.

RINGICULA, species aff. R. TRIDENTATA Guppy

Shell is ovate, four whorled; whorls inflated, slightly depressed in front of the grooved suture. Sculpture consists of spiral striae only visible on the penultimate and body whorls; on the penultimate

[5]Acad. Nat. Sci. Phila. Proc., pt. 2, p. 311.

whorl, two to three striae are behind the suture; and on the body whorl, about seven striae occur on the anterior one-half the whorl. Columella with three strong, sharp, twisted folds, the anterior one being much stronger.

Measurements of the larger specimen: Altitude 1.8 mm.; greatest diameter 1.2 mm.

The indeterminate form is related to *Ringicula tridentata* Guppy.

Occurrence.—There are two immature and corroded specimens from station 9027, Brasso-Gran Couva Road, 100–200 yards west of Brasso.

Genus TEREBRA Adanson

TEREBRA (STRIOTEREBRA) TRINITATENSIS, new species

Plate 1, fig. 8

Shell small, moderately slender, surface glazed, with two and one-half nuclear and seven postnuclear whorls; nuclear whorls smooth, inflated, constricted at the suture; outline of postnuclear whorls nearly flat on the earlier whorls but gradually rounding out on the later whorls. Suture shallowly grooved, constricting the later whorls. Subsutural band narrow. Axial sculpture consists of about 16 prominent, narrow, cordlike, riblets, offset, keeled and retractive over the subsutural band, arched centrally and protractive behind the suture. Spire whorls without distinct spiral sculpture. Base both axially and spirally sculptured—the spiral sculpture consists of about twelve wide bands becoming nodulous at the intersection with the riblets. Anterior canal long and twisted. Outer lip broken away; inner lip smooth. Siphonal fasciole provided with raised bands.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352622) measures: Altitude 9 mm.; maximum diameter 3 mm. Species based upon a single specimen.

Occurrence.—Middle or lower Miocene: In flood-wash, one mile south of Brasso, Trinidad, British West Indies.

TEREBRA (STRIOTEREBRA) BRASSOËNSIS, new species

Plate 1, fig. 5.

Shell small, stout, tip broken off, only five whorls remaining; most prominent feature of sculpture consists of two subsutural bands of equal width, separated by a narrow sulcus, nodulus on the earlier whorls and ridged on later where overrun by stronger axials, both bands occupying more than one-half the area between the sutures. Axial sculpture consists of moderately strong, narrow riblets continuous with the nodules and extending from suture to suture, retractive over the nodules and protractive forward, and also of finer rib-

lets between the stronger ones. Spiral sculpture consists of many narrow bands separated by a narrower sulcus; base similarly sculptured to spire, ornamentation extending to keel of siphonal fasciole. Anterior canal twisted; outer lip partly broken away; inner lip covered with callus; columella smooth with only a slight trace of biplication, the anterior fold well developed; the anterior keel of siphonal fasciole moderately developed.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352623) measures: Altitude 6.2 mm.; maximum diameter 2.4 mm.

The sculpture of the new species resembles that of *Terebra sulcifera* Sowerby. The second subsutural band is weaker in Sowerby's species, but the biplication on the columella is much more strongly developed.

Occurrence.—Middle or lower Miocene: Flood-wash, 1 mile south of Brasso, Trinidad, British West Indies.

TEREBRA, species indeterminable

There are several fragments of the genus *Terebra* from station 9212 whose specific relationship can not be definitely determined. In so far as can be observed, they are similar to forms occurring in the Gurabo formation of the Dominican Republic.

Genus CONUS Linnaeus

CONUS SPRINGVALEËNSIS, new species

Plate 1, figs. 3, 6

Shell rather small, moderately slender, eight whorled including a small erect nucleus. Spire slightly concave in contour, altitude 5 mm. above the plane of the spire. Whorls excavated and indistinctly marked within by growth lines and bordered in front by a sharp, weakly denticulated carina. Suture loosely appressed. Last whorl gradually tapers to near the base where it is slightly incurved dextrally and reflected. Spiral sculpture on the lower half consists of about eleven flat bands, wide above and separated by striae, and narrower below with interspaces equal in width to the bands. Outer lip sharp. Aperture 2 mm. in greatest width, slightly wider below. Columella slightly inflected and reflected.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352644) measures: Altitude 27 mm.; alt. of spire 5 mm.

In a general way, the new species resembles *C. chipolanus* Dall from the Chipola marl member of the Alum Bluff formation of Florida, but differs from this species in possessing a more excavated and carinated spire whorl and a less tapering body whorl.

Occurrence.—Upper Miocene: Springvale, near Couva, Trinidad, British West Indies.

CONUS TRINITATENSIS, new species

Plate 1, figs. 1, 4

Shell small, moderately stout, diameter about one-half length of shell, eight and one-half whorled. Last two whorls of spire nearly flat, the rest rising rather steeply to an altitude 4 mm. above the plane of the spire. Nucleus small, smooth, with one and one-half whorls. First two postnuclear whorls carinated and turrited. Suture of the earlier whorls shallowly channeled and somewhat appressed, on later whorls less appressed and deeper channeled. Last three whorls moderately medially concave. Sculpture of spire consists of a strong, flat, raised spiral band in front of the suture closely followed by three small, rounded, equally spaced spiral threads occupying two-thirds of the remaining space. Concave arcuate growth lines overrun spirals and extend from suture to suture. Last whorl with low carina at the shoulder and sculptured mainly on the lower two-thirds with narrow bands with wider interspaces occasionally carrying an intermediate thread. Outer lip broken away. Aperture moderately narrow. Columella nearly straight, slightly incurved and dorsally reflected.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352645) measures: Altitude 20 mm.; maximum diameter 10 mm.; altitude of spire, 4 mm.

The most prominent character of the new species is the strong spiral band in front of the suture of the spire. It is somewhat similar to *C. submonilifera* Gardner (Ms.), a species occurring in the Shoal River marl member of the Alum Bluff formation of Florida, but possesses a proportionally lower spire and different arrangement of spirals.

Occurrence.—Middle or lower Miocene: Guaico-Tamana Road, 2 chains east of mile 13 from junction with Eastern Main Road, Trinidad, British West Indies.

CONUS MANZANILLAËNSIS, new species

Plate 2, figs. 5, 10

Shell of medium size, broadly conic, last three postnuclear whorls flat, remainder rising rather steeply to an elevation 5 mm. above the plane of the spire, with eight postnuclear and one and one-half nuclear whorls. Nuclear whorls slightly corroded but apparently smooth. First four postnuclear whorls spirally coronate and carnate behind the channeled suture, remaining whorls sculptured with faint concave growth lines and faint concentric lines lying within the shallowly excavated anal fasciole. Last whorl slightly rounded below the carinated shoulder; below gradually sloping to

base. Sculpture on the lower two-thirds of last whorl consists of sharp, low, spiral threads with interspaces more than twice their width. Columella channelled near the base; below a sharp fold borders the canal. The specimen is partly crushed on the lower half and part of the shell is missing.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352646) measures: Altitude about 40 mm.; maximum diameter 22 mm.

This new species very closely resembles an undescribed species occurring in both the Baitoa and Cercado formations of the Dominican Republic and the Thomonde formation of the Republic of Haiti; but differs from these in possessing a coronate-carinate spiral on the early whorls and the absence of strong spirals within the anal fasciole.

Occurrence.—Middle of lower Miocene: Manzanilla Coast, Trinidad, British West Indies.

CONUS MULTILIRATUS WALLI, new subspecies

Plate 2, figs. 1, 9

The new subspecies differs from *Conus multiliratus* Böse in the following respects: The shell is less biconic, and has a proportionally shorter and more evenly conic spire; the spire is less attenuated toward the apex; the whorls less excavated and marked by a less prominent carina behind the suture; the body whorl tapers more evenly to the base and is less concave at its lower part.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352647) measures: Altitude 21 mm.; greatest diameter 11 mm.; altitude of spire 6 mm.

Type locality: 9219, Guaico-Tamana Road, 2 chains east of mile 13 from junction with Eastern Main Road, Trinidad, British West Indies. J. A. Bullbrook, collector.

Occurrence.—Middle of lower Miocene: In flood-wash; 9212, 1 mile south of Brasso.

The new subspecies is named in honor of G. P. Wall, a pioneer geologist in Trinidad.

CONUS, species indeterminable

Fragments and casts of the genus *Conus* occur at stations 9197–a. 8301, 8299, 9205, 9212, 9219, 9220, and 9221. These are too poorly preserved for specific comparison.

Genus TURRICULA Schumacher

TURRICULA SPRINGVALEËNSIS, new species

Plate 2, fig. 2

The species is founded upon a single mutilated specimen, the early whorls and part of the body whorl being broken away. Shell is large, fusiform, turrited, strongly axially and spirally sculptured,

with a high spire and a long anterior canal. Whorls uniformly enlarging in size, strongly constructed at the suture, concave at the anal fasciole, and strongly shouldered a little below the middle of the volution. Body whorl strongly shouldered above, and steeply sloping to the nearly straight canal. Suture shallowly grooved and wavy. Axial sculpture consists of seven strong, somewhat nodular ribs in front of the anal fasciole; ribs are more prominent on the earlier whorls and lower on the body whorl—scarcely extending down the basal slope. Spirally sculptured with about seven strong cords, overrunning the axials and valleys, and by three or four weak spirals in the anal fasciole; on the body slope and canal, the spirals continue with equal strength; a weak spiral is in front and marginates the suture. Aside from the axials and spirals, fine, close-set growth lines overrun the sculpture, arcuate in the anal fasciole and somewhat irregular over the rest of the shell. The anterior canal is long and slightly reflected anteriorly.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352627) measures: Altitude 44 mm.; greatest diameter 15 mm.

This species suggests *Turricula lavinoides* Olsson from the Gatun Stage, Banana River, Costa Rica, but the new species here described is a more slender shell and has a less inflated body whorl.

Occurrence.—Upper Miocene: Springvale, near Couva, Trinidad, British West Indies.

TURRICULA (?), species indeterminable

There are two specimens from station 9197, Manzanilla Coast, which are too poorly preserved for specific determination. In a general way they resemble *Surcula vicksburgensis* (Casey), a species from the Oligocene of the Gulf Coastal Plain. The shell is fusiform, turrited, high spired, and has a long anterior canal. Whorls strongly constricted at the suture with the prominent periphery in front of the anal fasciole. Sculpture mainly consists of narrow spiral keels.

Genus TURRIS Bolton

TURRIS BRASSOËNSIS, new species

Plate 2, figs. 7, 8

Shell fusiform, moderately slender, prominently spirally sculptured, nine to ten whorled; spire high, weakly constricted at the suture. Nuclear whorls distinctly set off from the postnuclear whorls. First two nuclear whorls rather small, slightly inflated and very minutely axially sculptured; four following whorls, strongly inflated and each rapidly enlarging. Sculpture of nucleus consists of many prominent, nearly vertical, narrow axials extending from

suture to suture, and much finer spirals overrunning the axials and situated on the anterior third of the whorl. Postnuclear whorls with a wide, rounded-bottomed sulcus behind the suture and another narrower sulcus at the posterior third of the whorl. Spiral sculpture consists of a prominent, sharp, smooth ridge, adjacent and anterior to the suture, and two strong cords overrunning the ribs on the anterior half of the whorl; besides these, there is a single spiral thread just in front of the suture, two in the sulcus behind the ribs and a stronger and sharper one in front of the ribs. Axial sculpture consists of many, weakly nodular ribs occupying the anterior half of the whorl, and many, evidently growth lines, retractive over the posterior part of the whorl and mainly protractive over the anterior part. The base and pillar are sculptured with spiral cords and close-set growth lines. Outer lip broken away at the margin, within there are six sharp spiral threads extending nearly to the margin. Anterior part of canal broken off. Columella smooth, covered with callus.

The description is made from two specimens, a larger specimen showing the nature of the sculpture and a smaller specimen possessing a well preserved protoconch.

Dimensions of the larger cotype (U. S. Nat. Mus. Cat. No. 352626): Length 16 mm.; greatest diameter 6 mm.

Type locality: Station 9212. In flood-wash, one mile south of Brasso, Trinidad, British West Indies.

J. A. Bullbrook, collector.

The new species here described is similar to *Pleurotoma pontonensis* Dall (Ms.) from Ponton, Santo Domingo, but the latter species possesses a different type of nucleus, a more excavated sulcus behind the ribs and more fine spirals in front of the carinate spiral just anterior to the suture.

The nature of the sculpture is very similar to a new unpublished species from the Shoal River marl member of the Alum Bluff formation, Florida. The described species is also related to *Pleurotoma* (*Gemmula*) *vaningeni* Brown and Pilsbry [6] from the Gatun formation, Panama. The latter species has a smaller apical angle and apparently lacks the paired spiral cords over the ribs.

Drillia vaningeni var. *sancti andrae* Maury [7] is related to the new species and may prove to be a very closely related species when complete forms are obtained.

Occurrence.—Middle or lower Miocene: 8302.

TURRIS VANINGENI var. MACHAPOORENSIS (Maury)

Drillia vaningeni var. *machrapoorensis* MAURY, Bull. Amer. Paleont., vol. 10, no. 42, p. 191, pl. 32, figs. 5, 9, 1925.

Occurrence.—Middle or lower Miocene: station 9219.

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[6] Acad. Nat. Sci. Phila. Proc., vol. 64, p. 505, pl. 22, fig. 4, 1913.

[7] Bull. Amer. Paleont., vol. 10, no. 42, p. 191, pl. 32, figs. 1, 14, 1925.

TURRIS, aff. T. ALBIDA Perry

There are from stations 8302, 9212, 9219, 9220, and 107146 (U. S. Nat. Mus. Cat. No.), Ditrupa bed (Guppy), several either young or poorly preserved specimens apparently belonging to the group of *Turris albida* Perry. The condition of preservation hardly justifies a specific comparison.

Genus DRILLIA Gray

DRILLIA CONSORS BULLBROOKI, new subspecies

Plate 3, fig. 10

Drillia consors Maury, Bull. Amer. Paleont., vol. 10, no. 42, p. 190, pl. 32, fig. 10, 1925.

Shell rather small, moderately stout, fusiform, with five remaining whorls, nucleus decollate; whorls slightly inflated, anterior ones more so than posterior; weakly constricted at the suture; spiral sculpture stronger than axial. Suture shallowly grooved and wavy. Anal fasciole wide, shallow, and sculptured with three rounded spiral threads. Axial sculpture (20 on the penultimate whorl) on the spire whorls consists of slightly protractive, nodulous at the intersections of the spirals, ribs separated by interspaces one-half their width and extending from the anal fasciole forward to the suture. Spirally sculptured with a strong keel just in front of the suture and two or three microscopic threads on the lower border of the suture, and in front of the anal fasciole with four narrow prominent bands separated by interspaces of about equal width in which there are two fine microscopic threads. Base similarly cancellate-sculptured except that there are one or two more microscopic threads in the interspaces between the spiral bands. Outer lip broken away at the margin. Inner lip covered with callus, a heavier patch being just underneath the suture. Pillar nearly straight; slightly concave medially.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352628) measures Height 18 mm.; greatest diameter 6 mm.

The type locality of *Drillia consors* Sowerby is Santo Domingo. This differs from the subspecies here described in possessing more spiral threads, and the absence of secondary microscopic spirals and nodules at the intersection of the axials and spirals. One specimen at each station, 8558 and 8668, collected from the Baitoa formation in the Dominican Republic and designated "*Drillia consors* Sowerby n. sub. sp. a,"[8] apparently belongs to the same new subspecies as here described.

Pleurotoma alesidota, var. *magna* Böse, from Paso Real cerca de Tuxtepec, Oaxaca, resembles the new subspecies but the sculpture of

[8] Woodring, W. P., and Mansfield, W. C., A geological reconnaissance of the Dominican Republic, Geol. Survey Mem., vol. 1, p. 113, 1921.

the latter is more open and possesses nodules at the intersection of the axials and spirals.

Occurrence.—Middle or lower Miocene; Guaico-Tamana Road, 2 chains east of mile 13 from junction with Eastern Main Road, Trinidad, British West Indies.

DRILLIA CONSORS TRINITATENSIS, new subspecies

Plate 3, figs. 12, 13

Shell rather small, moderately stout, fusiform, with five remaining whorls on the larger cotype, smaller cotype with anterior whorl of nucleus partly intact; spire whorls slightly inflated; suture shallowly grooved and loosely appressed; anal fasciole rather wide, shallow and marked by two to three spiral threads and close-set arcuate growth lines. Nucleus, as revealed, inflated and smooth. Axial sculpture of postnuclear whorls (12 on the penultimate whorl of larger cotype but other specimens have up to 17) slightly protractive, rounded ribs, stronger than the spirals, and extending from the anal fasciole forward to the suture. Spirally sculptured in front of the suture with a keel and, between the anal fasciole and forward suture on the earlier whorls, with four close-set threads and, on the latter whorls, with four low, close-set threads separated by stria, all scarcely overrunning the axials. Base similarly sculptured except that the striae between the spiral threads shallowly incise the ribs. Outer lip broken away at the margin; pillar with wash of callus, nearly straight and slightly reflexed anteriorly.

Dimensions: Larger cotype (U. S. Nat. Mus. Cat. No. 352629) measures: Height 13 mm.; greatest diameter 4.3 mm.

The new subspecies here described is represented at only one locality and differs from *Drillia consors*, subspecies *bullbrooki* in possessing close-set crowded spiral sculpture and the absence of nodules at the intersections of the axials and spirals.

Pleurotoma alesidota, var. *magna* Böse, from Paso Real cerca de Tuxtepec, Oaxaca, is very closely related to the new subspecies, but it is a larger and stouter shell than the Trinidad form.

Occurrence.—Middle or lower Miocene: In flood-wash, 1 mile south of Brasso, Trinidad, British West Indies.

DRILLIA PENNYI, new species

Plate 3, fig. 2

Shell small, solid, surface glazed; axial sculpture over the body of the whorl more prominent than spiral; with two and one-half nuclear and seven postnuclear whorls; whorls inflated and tightly constricted at the suture. Suture moderately appressed and wavy; anal fasciole wide, undulating, slightly inclined posteriorly. Nu-

clear whorls smooth, rather large, moderately constricted at the suture. Postnuclear whorls axially sculptured (nine on the last whorl) with strong, rather sharp ribs over the anterior two-thirds of the whorl, almost suppressed over the anal fasciole, nodular and protractively offset on the subsutural band; spirally sculptured with a strong, nodular, subsutural band and anteriorly, between the anal fasciole and suture on the five later whorls, marked by five interaxial bands, separated on the earlier whorls by narrow striae and on the later whorls by interspaces one-half their width. On the base, the axials gradually diminish in size and terminate halfway across the canal; below, the spirals continue to the end of the canal. Outer lip broken away. Inner lip smooth, borders overlapping the pillar. Anterior canal rather short and slightly curved dextrally. The species is named in honor of F. W. Penny, the collector.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352630) measures: Altitude 9.3 mm.; greatest diameter 3 mm.

This species is characterized by its nodulous, subsutural band.

Occurrence.—Middle or lower Miocene: In flood-wash, 1 mile south of Brasso railway station.

DRILLIA PENNYI ACARIA, new subspecies

Plate 1, fig. 2

Shell, small, slender, glazed, prominently axially sculptured, marked by a strong subsutural band and consists of one and one-half nuclear and seven postnuclear whorls. Spire whorls constricted at the suture; suture moderately appressed and wavy. Nucleus small, globular, and smooth. Postnuclear whorls with strong ribs (13 on the last whorl), nodular on the early whorls and rounded on the later, suppressed within the indistinct anal fasciole and protractively offset and nodular on the subsutural band. Spirally sculptured between the axials with striae, indistinct on the earlier whorls and distinct on the later whorls, separated by low, narrow, flat bands. On the base, the axials terminate at the posterior part of canal; the spirals at first overrun the axials, but later continue alone to the end of the canal. A strong varix is situated behind the outerlip. Inner lip formed of a thin wash of callus, exteriorly it loosely overlaps the pillar; anterior canal short.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352631) measures: Altitude 5.2 mm.; greatest diameter 2 mm.

The new subspecies here described differs from *Drillia pennyi*, new species, in possessing a smaller and shorter nucleus. It is also a more slender shell and has a less distinct anal fasciole.

Occurrence.—Middle or lower Miocene: In flood-wash, 1 mile south of Brasso, Trinidad, British West Indies.

DRILLIA TRIDADINA, new species

Plate 3, fig. 11

Shell small, stout, solid, glazed, strongly constricted at the suture, strongly axially sculptured and consists of two and one-half nuclear and six and one-half postnuclear whorls. Suture appressed and wavy. Nucleus rather small, glassy, smooth with whorls moderately inflated between the grooved sutures. Postnuclear whorls constricted by a low-lying, flat, wide band bordered anteriorly by a microscopic stria and posteriorly by the suture. Axial sculpture consists of strong, rather sharp, slightly protractive ribs (10 on the penultimate whorl), extending from the anal fasciole forward to the suture. Spiral sculpture—only visible on the anterior whorls—faint, consisting of five or six wide-spaced, shallow striae, separated by wide, nearly flat areas. The posterior one-half of the canal is sculptured with three spiral bands and subdued axials forming a reticulate ornamentation; anteriorly, the ribs become obsolete and the sculpture consists of fine, unequally spaced spirals forming the siphonal fasciole. Margin of outer lip broken away. Inner lip consists of a thin callus and externally loosely overlaps the pillar. Canal short and dextrally curved.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352632) measures: Altitude 7.5 mm.; greatest diameter 2.5 mm.

The new species here described is characterized by its cingulum situated anterior to the suture, strong axials, and faint spirals.

Occurrence.—Middle or lower Miocene: In flood-wash, 1 mile south of Brasso, Trinidad, British West Indies.

DRILLIA DADITRINA, new species

Plate 3, figs. 1, 5

Shell rather slender, solid, semiporcellaneous, strongly axially sculptured, with one and one-half nuclear and six moderately inflated postnuclear whorls; anal fasciole wide, undulating, without spiral striae; suture narrow and shallowly grooved. Nuclear whorls smooth, inflated, of medium size. Postnuclear whorls axially sculptured with strong, broad, rounded, nearly vertical ribs (six on the penultimate whorl) extending across the whorl from the subsutural cord forward to the suture, suppressed across the anal fasciole and strong over the middle of the whorl; on the last whorl, the axials terminate on reaching the canal. Spirally sculptured on the earlier whorls by two, strong, rather wide-spaced, paired cords, the posterior one bordering the anal fasciole—both overrunning the axials; on the later whorls an intermediate cord of equal strength comes in; in addition to these cords, there is another cord in front of and marginat-

ing the suture, and behind it a smaller one. On some specimens, a little larger than the type and believed belonging to the same species, the spirals on the later whorls increase to four, the one behind the suture becoming stronger; the front of last whorl has 14 spirals below the anal fasciole. Outer lip sharp. Anal sinus deep. Inner lip smooth, closely adhered to body wall above and loosely overlaps the pillar below. Anterior canal short, arcuate, anterior end twisted a little backward and dextrally.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352633) measures: Altitude 8.4 mm.; greatest diameter 2.8 mm.

The new species is similar to *Drillia winchesterae* Pilsbry from Santo Domingo, but when compared with the figure it appears to have a shorter anterior canal and lacks the spiral striae in the anal fasciole and between the spiral cords. The new species is also somewhat similar to *Drillia senaria* Woodring (Ms.) from the Bowden marls, Jamaica.

Occurrence.—Middle or lower Miocene: In flood-wash, 1 mile south of Brasso, Trinidad, British West Indies.

DRILLIA PROPEFUSIFORMIS, new species

Plate 2, figs. 3, 4

Shell large, slender, solid, fusiform, strongly axially and spirally sculptured and consists of about one and one-half rather small, apparently smooth, corroded nuclear and ten slightly inflated postnuclear whorls; suture closely adherent, flexuous, and shallowly channeled. Postnuclear whorls sculptured with four strong, broad, rounded, vertical ribs, separated by broad valleys, undulating the broad anal fasciole, strongest over the middle of the whorl; on the last whorl the ribs become obsolete at the base. Spirally sculptured by a strong subsutural carina, closely marginating the anal fasciole and also spirally sculptured between the anal fasciole and the following suture on the earlier whorls by two and on the later whorls by four strong, equal-sized, semirounded, broadly spaced cords overrunning the axials and valleys; the postsutural spiral on the later whorls marginates the suture and at times overlaps it. On the front of the last whorl there are 16 primary spirals from the anal fasciole to the end of the anterior canal. Besides these primary spirals, there are sharp, secondary spiral threads overrunning the whole surface of the shell—about seven in the anal fasciole and about five between the primary spirals. Aperture moderately wide medially, slightly narrower above and gradually narrowing below. Outer lip sharp, not lirate within. Anal sulcus deep and moderately wide. Inner lip callus closely adhered to body wall above and loosely overlapping pillar below. Anterior canal short. Anterior extremity slightly recurved and dextrally twisted.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352634) measures: Altitude 34 mm.; greatest diameter 9 mm.

This new species resembles in a general way *Drillia fusiformis* (Gabb) from the Gurabo formation, Dominican Republic, but differs from that species in possessing fewer axial ribs, a less constricted suture, a narrower aperture, and a smooth interior outer lip.

A very closely related form to the new species occurs at station 8519, Dominican Republic, a horizon referred to the Gurabo formation.

The Recent analogue appears to be *Drilla grundlachi* Dall and Simpson from Mayaguez Harbor, Porto Rico.

Occurrence.—Middle or lower Miocene: Guaico-Tamana Road, 2 chains east of mile 13 from junction with Eastern Main Road, Trinidad, British West Indies.

DRILLIA, species, aff. D. FUSIFORMIS (Gabb)

Several young and fragmental adult specimens from stations 9212 and 9219 apparently belong to the group of *Drilla fusiformis* (Gabb), but these are considered inadequate for definite specific comparison.

DRILLIA INNIADDA, new species

Plate 3, figs. 4, 9

Shell small, stout, semiporcellaneous, strongly axially sculptured and consists on the larger cotype of four slightly inflated whorls, the nucleus and early whorls broken off, and on the smaller cotype of one and one-half nuclear and six postnuclear whorls. Suture distinct, grooved, not appressed. Nucleus rather small, apical whorl minute; whorls smooth and rounded. Postnuclear whorls sculptured with about ten, strong, arcuate, triangular, sharp-edged ribs, separated by narrow grooved interspaces. At the base of the last whorl, the ribs diminish in size and are replaced on the canal by small, rounded, crowded growth lines which twist dextrally and overrun the lower part of the pillar. In addition to the axials, there are many, close-set, irregular, microscopic growth lines overrunning the sides of the axils and interspaces. Spiral sculpture is very obscure, consisting only of a narrow subsutural band and a faint interaxial stria on the posterior third of the whorl. Aperture rather wide. Anal sulcus apparently wide and situated near the suture. Margin of inner lip erect and partly overlaps the pillar. Canal rather short and slightly twisted.

Dimensions: Cotypes (U. S. Nat. Mus. Cat. No. 352635) measure: (Larger cotype) altitude 9 mm.; greatest diameter 3.3 mm.; (smaller cotype) altitude 6 mm.; greatest diameter 2.1 mm.

Occurrence.—Middle or lower Miocene: In flood-wash. 1 mile south of Brasso, Trinidad, British West Indies.

DRILLIA NITRINA, new species

Plate 3, fig. 3

Shell small, rather stout, semiporcellaneous, strongly axially sculptured, six whorled including one nuclear whorl. Nucleus large, smooth and bulbous. Postnuclear whorls slightly inflated; suture distinct, shallowly grooved, with a low poorly defined band below. Anal fasciole moderately wide, not depressed, undulating. Sculpture consists of about eleven, vertical ribs extending with equal strength across the whorl, separated by rounded interspaces of about equal width; on the body whorl, the ribs become obsolete on reaching the canal. Spirally sculptured on the later whorls, between the axials, with five striae separated by flat rather wide bands; on the body whorl and overrunning the canal, there are 15 of these bands separated by wider interspaces, especially those over the canal. Outer lip broken away. Pillar smooth. Siphonal canal short and anteriorly, dextrally twisted.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352637) measures: Altitude 6.5 mm.; greatest diameter 2.5 mm.

Occurrence.—Middle or lower Miocene: In flood-wash, 1 mile south of Brasso, Trinidad, British West Indies.

DRILLIA INADRINA, new species

Plate 3, fig. 6

Shell small, moderately slender, porcellaneous, strongly axially sculptured and consists of one and one-half nuclear and six postnuclear whorls. Suture closely appressed and wavy—the scallops entering the interaxial hollows. Nucleus quite small, smooth and inflated. Postnuclear whorls sculptured with strong, semiacute, widely spaced, sigmoid ribs (eight on the penult whorl), strongest anteriorly and weakest posteriorly, extending from just in front of the sutural margin forward to the following suture; the axials on each whorl are opposite the wide, concave, interaxial spaces on the adjoining whorl. Over the base, the axials gradually diminish in size and become obsolete at the juncture of the anterior canal. In front of the suture and between the axials, there is a slightly raised area. Whorls without spiral sculpture except for a single, indistinct stria midway between the sutures. Outer lip sharp. Inner lip smooth, the exterior margin overlapping the canal; canal short, arcuate and incurved. The siphonal fasciole is bounded above by a spiral thread.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352638) measures: Altitude 6.6 mm.; greatest diameter 2.2 mm.

Occurrence.—Middle or lower Miocene: In flood-wash, 1 mile south of Brasso, Trinidad, British West Indies.

The new species is similar to *Drillia orthopleura* Pilsbry and Johnson, from Santo Domingo, but the latter species has a larger shell with a longer anterior canal.

DRILLIA MANZANILLAËNSIS, new species

Plate 2, fig. 6

A single, poorly preserved specimen was collected at station 9197, Manzanilla Coast, Trinidad. The shell is strongly axially sculptured, consisting of (10 on the penultimate whorl) seminodulous ribs. Suture is closely appressed and overlaps the preceding whorl. Anal fasciole broad and deeply depressed, below which is the prominent shoulder. Spiral sculpture of wide-spaced, fine, raised threads overrunning the axials and interspaces and extending over the base and canal. Canal rather long; extremity gone.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352639) measures: Length 13 mm.; greatest diameter 5.5 mm.

Horizon: Middle or lower Miocene.

I am unable to find a very close relative to the described species.

DRILLIA NIADDRINA, new species

Plate 4, figs. 6, 8

Shell rather small, turrited, strongly axially sculptured and consists of seven, inflated, rapidly enlarging whorls on the larger cotype—tip broken away—and two and one-half nuclear and five postnuclear whorls on the smaller cotype. Suture appressed, distinct and wavy. Nuclear whorls smooth, rounded; apical one minute and glassy. Postnuclear whorls constricted at the suture and below it and strongly shouldered in front of the anal fasciole. Axial sculpture consists of 16 on the larger specimen and 14 on the smaller, narrow, rather sharp, sigmoid ribs, extending from suture to suture and separated by rounded bottomed interspaces. Spiral sculpture consists of a low subsutural band and seven interradial striae below this band, being separated by low, flat narrow bands. On the body whorl, the ribs become obsolete at the base, overrun the axials, and are separated by wider interspaces; forward they continue with equal strength over the canal. In addition to the spirals and axials, growth lines occur on the subsutural band and anal fasciole and between the ribs over the base. The outer lip and lower part of the canal are broken away.

Dimensions: Cotypes (U. S. Nat. Mus. Cat. No. 352636) measure: (Larger cotype) altitude 11 mm.; greatest diameter 5.3 mm.; (smaller cotype) altitude 7.6 mm.; greatest diameter 3.1 mm.

Occurrence.—Middle or lower Miocene: In flood-wash, 1 mile south of Brasso, Trinidad, British West Indies.

DRILLIA RITANIDA, new species

Plate 4, fig. 10

Shell small, moderately stout, six and one-half whorled including one and one-half nuclear whorls. Nucleus smooth and bulbous. Post-nuclear whorls with a strong subsutural cord marginating the rather loosely appressed suture; anal sulcus wide, slightly undulated, roundly excavated and marked with two or three low spiral threads and axially with arcuate growth lines. Axial sculpture of (13 on the last whorl) strong, semicarinate, vertical ribs, strongest at and abruptly rising from the anal fasciole, and continuing slightly reduced forward to the suture, separated by rounded excavated interspaces of about equal width to the ribs; on the last whorls, these ribs continue to the siphonal fasciole. Spiral sculpture of about six, flat, interaxial, narrow bands with equal interspaces; on the back of the body whorl, there are 15 spirals between the anal fasciole and the siphonal fasciole—those over the base and canal being much stronger and wider spaced. Aperture obovate. Sinus rounded, moderately wide and deep and situated below the subsutural cord. Canal short and slightly recurved.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 115581) measures: Altitude 8.5 mm.; greatest diameter 4 mm. The species is founded upon a single specimen.

Type locality: Trinidad, British West Indies. Guppy.

This specimen with another belonging to a different species is deposited in the U. S. National Museum and was labeled *Pleurotoma luctuosa* Orbigny, Pliocene, Guppy. The locality may be Matura as *P. luctuosa* is listed from Matura by Guppy.[9]

The new species is somewhat similar to *Drillia ebenina* Dall, a species reported by Dall [10] from the Pliocene to Recent, but Dall's species has a greater apical angle, a smaller nucleus, and more crowded spirals overrunning the base and canal than the new species here described.

DRILLIA, species, aff. D. RIOGURABONIS Maury

Plate 3, fig. 8

There is a single worn specimen from station 9224, Springvale, which, in a general way, resembles *Drillia riogurabonis* Maury from

[9] Sci. Asso. Proc., Trinidad, p. 159, 1867.
[10] Wagner Free Inst. Sci., vol. 3, pt. 1, p. 33, 1890.

the Gurabo formation, Dominican Republic. Unfortunately the specimen is too corroded for exact specific comparison.

Genus MANGILIA Risso

MANGILIA MICROPLEURA Guppy

Plate 3, fig. 7

Mangelia micropleura GUPPY, Sci. Assoc.. Trinidad Proc., p. 171, 1867 (described) ; Geol. Mag. London. new ser., decade 2, vol. 1, p. 410, pl. 18, fig. 6, 1874.

The following is Guppy's original description of this species:

" Subfusiform, longitudinally ribbed, the ribs crossed by numerous striae, of which a prominent one forms an angle on the upper part of the whorls; last whorl longer than the spire; aperture rather narrow, lanceolate, with a sinus on the posterior part of the thickened peristome."

" Pliocene, Matura. Allied to *M. pulchella*. The ribs vary considerably as to size and distance apart. It was denominated *M. taeniata* in my list of 1864." [Unable to find it in this list.]

Redescribed:

There are in the United States National Museum (Cat. No. 115583) six specimens labeled *Mangelia micropleura* Guppy (types). Matura, Trinidad (Guppy), all of which bear the same specific characterization. The shell is subfusiform, rather stout, solid, strongly axially sculptured and possesses about two nuclear and four postnuclear whorls. Nuclear whorls are strongly inflated; the second one is sculptured with many threadlike, intrasutural axials and a fine. anterior medial, spiral thread. Postnuclear spire whorls with a central, angled periphery; suture narrowly and shallowly grooved. Axial sculpture consists of about nine, strong, slightly arcuate, sharp, intrasutural ribs, intercalated by rounded valleys wider than the ribs. Spirally sculptured with a strong intra-axial cord at the periphery of the whorl and by about two smaller equally spaced cords between the peripheral cord and the anterior suture. Body whorl longer than spire, sculptured axially with strong ribs extending along the canal into the siphonal fasciole; spirally sculptured with 10 to 12 low cords, widely spaced over the slope and prominent and closely spaced over the siphonal fasciole. Aperture uniformly rather narrow. Outer lip sharp with a strong varix behind and near the margin. Anal sinus deep, wide, rounded, obliquely placed and situated near the suture. Anterior canal short and wide.

Dimensions: Largest specimen: Altitude 6 mm.; greatest diameter 2.5 mm.; length of aperture 2.5 mm.

This species is similar to *Mangilia plicosa* C. B. Adams, a species reported from the Pliocene to the Recent.

CYTHARA, species indeterminable

There is a single specimen from station 9212 which is too poorly preserved for specific comparison. In a general way, it resembles *Cythara cercadica* Maury from Bluff 1, Cercado de Mao, Dominican Republic.

Genus GLYPHOSTOMA Gabb

GLYPHOSTOMA CARONENSIS, new species

Plate 4, fig. 1

Shell small, slender, fusiform, solid, stronger axially sculptured than spirally, and consists of two and one-half nuclear and five post-nuclear whorls; whorls inflated and constricted at the suture; suture loosely appressed and wavy. Apical whorl minute, succeeding one larger, inflated and smooth; anterior nuclear whorl faintly sculptured with fine, close-set axials and fine spiral threads. Postnuclear whorls sculptured with arcuate ribs—seven on the penultimate whorl; strong and rounded over the lower half of the whorl and narrower and lower over the anal fasciole. Spirally sculptured in front of the wide and slightly depressed anal fasciole with three narrow bands separated by about equal interspaces and overrunning both the axials and interspaces. On the back of the body whorl, there are 14 of these spiral bands with wider interstices extending from the anal fasciole across the canal. In addition to the axials and spirals, microscopic spiral striae overrun the shell between the spiral bands, and arcuate growth lines cross the anal fasciole. Aperture long and moderately wide. Anal sulcus, deep, well rounded and situated at the posterior extremity of the aperture. Outer lip with a heavy varix behind, upper and middle margin being broken away; columella, within, covered with thin wash of callus. Anterior canal moderately long, slightly expanded in front and twisted.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352640) measures: Altitude 8.6 mm.; greatest diameter 3.3 mm.; length of aperture 4.0 mm.

The type is founded upon a single specimen.

Occurrence.—Middle or lower Miocene: In flood-wash 1 mile south of Brasso, Trinidad, British West Indies.

GLYPHOSTOMA (?) TRINIADA, new species

Plate 4, fig. 4

Shell rather small, turrited, strongly axially and spirally sculptured and consists of two and one-half nuclear and five postnuclear whorls. Whorls rapidly enlarging, inflated, strongly constricted at the suture. Suture appressed, wavy, and marginated below by a small cord. Nucleus of moderate size: apical whorl minute, smooth,

and inflated. The sculpture on the first postnuclear whorl begins with a faint arcuate intersutural axial and by two spirals on the anterior part of the whorl; soon another spiral appears above giving the first postnuclear whorl a cancellate sculpture. Axially sculptured on the anterior whorls with about seven, small, arcuate riblets extending with equal strength from the subsutural cord forward to the suture, and separated by interspaces of more than twice their width. On the last whorl the ribs are a little stronger and extend down the steeply inclined basal slope to the canal. Spirally sculptured on the earlier whorls by two and on the later whorl by three, prominent cords overrunning the axials and extending from the excavated anal fasciole forward to the suture. In addition to these primary spirals, there are three or four secondary spirals on the anal fasciole and two or three between the primary spirals. On the back of the body whorl and over the canal, there are eleven primary spirals with one or two interspiral threads. Aperture of about equal length of spire; margin of outer lip broken away; anterior canal not long and slightly arcuate.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352641) measures: Altitude 5.2 mm.; greater diameter 2 mm.; length of aperture 2.5 mm.

Occurrence.—Middle or lower Miocene: In stream-wash, 1 mile south of Brasso, Trinidad, British West Indies.

GLYPHOSTOMA AMICTA RINTRIADA, new subspecies

Plate 4, figs. 2, 3

Shell small, solid, moderately slender, turrited, strongly axially and spirally sculptured and consists of four nuclear and four postnuclear whorls; whorls moderately inflated with periphery at lower one-half; suture loosely appressed. Apical whorl minute, smooth and inflated; following nuclear whorls with a strong spiral keel on the lower half of the whorl. Postnuclear whorls sculptured with about ten arcuate riblets separated by interspaces about twice their width, and extending from the suture behind the sloping anal fasciole to succeeding suture; on the body whorl, these axials extend nearly across the canal. Spirally sculptured with two rather prominent cords in front of the anal fasciole; the posterior one is a little stronger, corresponding to the keel on the nuclear whorl; the spirals overrun the axials and are nodular at the intersection with the ribs: anal fasciole with four or five smaller spiral threads. On the back of the body whorl, about twelve rather uniform sized spirals extend from the anal fasciole across the canal. Aperture rather long, with a deep and wide posterior sinus. Outer lip with a strong varix behind, marked within with three or four lirae below the anal sinus. Pillar with thin wash of callus. Siphonal canal short, recurved.

Dimensions: Cotypes (N. S. Nat. Mus. Cat. No. 352642) measure: (Larger cotype) altitude 4.3 mm.; greatest diameter, 1.8 mm. (est.); length of aperture, 1.5 mm.; (smaller cotype) altitude 3.2 mm.; greatest diameter 1.4 mm.; length of aperture 1.3 mm.

This new subspecies differs from *Glyphostoma amicta* (Guppy), a Bowden species, in having stronger nodules at the intersection of the ribs and spirals and the two spirals in front of the anal fasciole of more equal size.

Occurrence.—Middle or lower Miocene: In flood-wash, 1 mile south of Brasso railway station, Trinidad, British West Indies.

GLYPHOSTOMA (?) ADDRINA, new species

Plate 4, fig. 9

Shell small, solid, semiporcellaneous, strongly axially and spirally sculptured and consists of two and one-half nuclear and four postnuclear whorls. Whorls slightly inflated and rapidly enlarging; suture appressed, flexuous, bordered below by a strong semikeeled cord; anal fasciole wide, undulating, depressed, marked with indistinct spirals and arcuate growth lines. Nucleus large, smooth, and inflated. Postnuclear whorls axially sculptured with about seven strong rounded ribs, strongest below the anal fasciole, with interspaces of about equal width; on the body whorl, the axials become obsolete on reaching the canal. Spiral sculpture consists of, aside from the subsutural cord, two on the earlier whorls and three on the later whorls, cords which are a little stronger over the ribs and separated by a little wider interspaces. On the back of the body whorl, 14 spirals extend from the anal fasciole across the canal. Aperture wide and well-rounded above. Anal sinus wide, deep, and situated just anterior to the subsutural band; outer lip with a heavy varix near and behind the margin. Inner lip consists of a thin wash of callus with its lower external margin erect. Canal slightly expanded and recurved at its anterior extremity.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352643) measures: Altitude 6.2 mm.; greatest diameter 2.5 mm.; length of aperture 2.5 mm.

Occurrence.—Middle or lower Miocene: In flood-wash, 1 mile south of Brasso, Trinidad, British West Indies.

Genus MICRODRILLIA Casey

MICRODRILLIA TRINA, new species

Plate 4, fig. 5

Shell slender, rather solid, high spired, consisting of about four nuclear and four postnuclear whorls. Apical whorl blunt, scarcely inflated, and smooth; following nuclear whorls gradually enlarg-

ing, moderately inflated, constricted at the suture by a spiral thread, and axially sculptured with about twelve narrow, protractive, intrasutural ribs. Postnuclear whorls with a shallow, grooved suture and sculptured mainly with the semikeeled, spiral raised cords; a low keel is adjacent to and in front of the suture, followed by two stronger, wide-spaced raised cords; the anterior one is stronger and constitutes the periphery of the whorl, and is situated on the lower half of the whorl, in front of which is a wide rounded valley, bordered in front by a small postsutural keel. Axial sculpture consists of many threadlike, mainly protractive, growth lines, intercalating the spirals and extending up their slopes. On the body whorl, there are in all about seven spirals extending from the suture forward to the siphonal fasciole. Aperture rather wide; anal sinus apparently quite wide and shallow; margin of outer lip broken away, lirate within; inner lip consisting of callus, the lower margin is erect and forms the border of the short, reflected and dextrally twisted siphonal canal. Siphonal fasciole prominent, overrun by four spirals; a small chink is behind the siphonal fasciole.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352624) measures: Altitude 6 mm.; greatest diameter 2 mm.; length of aperture 2 mm.

An undescribed form in the United States National Museum collection from Monkey Hill, Panama, is very similar to the new species here described. It also belongs to the group of *Microdrillia hebetika* Gardner (Ms.) from the Chipola marl member of the Alum Bluff formation.

Occurrence.—Middle or lower Miocene: In flood-wash, 1 mile south of Brasso, Trinidad, British West Indies.

MICRODRILLIA PROPETRINA, new species

Plate 4, fig. 7

Shell small, solid, rather stout consisting of two and one-half nuclear and three postnuclear whorls. The first one and one-half nuclear whorls broadly conical, porcellaneous, smooth, except for a minute subsutural thread; anterior nuclear whorl with a subsutural band and marked with sharp arcuate riblets. Postnuclear whorls weakly constricted at the suture and slightly inflated between them; sculptured with three semikeeled, raised, spiral cords intercalated by rather wide rounded valleys, the posterior one marginates the suture, the medial and stronger one forms the periphery of the whorl, and the third stands midway between the second and the suture. Axially sculptured with fine, threadlike, arcuate, growth lines between the spirals and extending up their slope. On the back of the body whorl there are seven spirals extending from the anal fasciole forward to the siphonal fasciole. Aperture apparently wide; margin of outer

lip broken away; pillar with two oblique, rounded threads; anterior canal short, partly broken away.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352625) measures: Altitude 3.6 mm.; greatest diameter 1.5 mm.

The new species is very similar to *Microdrillia trina* but is much stouter than that species and possesses a much shorter nucleus.

Occurrence.—Middle or lower Miocene: In flood-wash, 1 mile south of Brasso railway station, Trinidad, British West Indies.

Genus BORSONIA Bellardi

Subgenus PARABORSONIA Pilsbry

BORSONIA (PARABORSONIA) BRASSOËNSIS, new species

Plate 5, fig. 8

Borsonia varicosa MAURY (not of Sowerby), Bull. Amer. Paleont., vol. 10, no. 42, p. 192, pl. 34, fig. 7, 1925.

Shell of medium size, biconic, solid, elaborately sculptured, seven and one-half whorled including one and one-half nuclear whorls. Nucleus smooth and globular. Postnuclear spire whorls gradually enlarging, in outline nearly straight, and only slightly constricted at the shallowly grooved suture. Sculpture consists of three primary spiral bands, finely tuberculate on the earlier whorls, coarsely elongate-tuberculate on the later whorls; the posterior band is widest and nearly marginates the suture except for two spiral threads just anterior to the suture, and separated in front by a rather wide channel in which are irregular axial growth lines; the two anterior bands are narrow, closely spaced, axially crossed and connected by elongate tubercles or short ribs and occupy the low periphery of the whorl; one or two granulose spiral threads are between the peripheral bands and the forward suture. Sculpture of the body whorl, below the peripheral bands and extending to the end of the canal, consists of about thirteen narrow, semituberculate, wide-spaced, spiral bands intercalated by a varying number of fine, spiral threads. Margin of outer lip broken, lirate within; columella with three plications—the posterior one is strong, the anterior one weak.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352661) measures: Altitude 14.3 mm. (end of canal slightly broken away); greatest diameter 6.5 mm.

The new species closely resembles *Borsonia* (*Paraborsonia*) *varicosa* (Sowerby). Sowerby's species, however, possesses a higher peripheral bilirate band, and a lower and more granulose subsutural band.

Occurrence.—Middle or lower Miocene: In flood-wash, 1 mile south of Brasso, Trinidad.

Genus CANCELLARIA Lamarck

CANCELLARIA SPRINGVALEËNSIS, new species

Plate 2, fig. 12

Shell of medium size, solid, strongly axially and spirally sculptured and consists of two and one-half nuclear and four postnuclear whorls. Nucleus smooth, naticoid, whorls rapidly enlarging, initial turn minute. Postnuclear whorls strongly shouldered and moderately tabulated in front of the channeled suture. Axial sculpture of (12 on the penultimate whorl) rounded, rather narrow, retractive ribs, extending posteriorly nearly to the suture; ribs becoming nearly obsolete over the body whorl on reaching the base; spiral sculpture of two slightly weaker bands over the slope below the suture and of four stronger, widely spaced, flat bands extending from the periphery forward to the suture—the one at the periphery is slightly stronger and seminodulous at the intersection with the ribs; body whorl with 14 spiral bands, with intercalations of about twice their width. Aperture rather narrow, hemispherical; outer lip with a strong varix behind and near the margin, within ornamented with 11 sharp lirae; parietal wall with a thin wash of callus insufficient to conceal the spirals. Columella triplicate, posterior one sharp and strong, nearly horizontally placed and externally continuous with the posterior border of the fasciole; anterior two obliquely placed, anterior one continuous with the inner margin of the canal. Between the two posterior plications, three short plications intervene. Siphonal fasciole separated from the pillar plate by a small chink and is overrun by three or four spiral threads.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352662) measures: Altitude 21 mm.; greatest diameter 13 mm.; length of aperture 11 mm.; width 4 mm.

The species is founded upon a single specimen. The new species here described closely resembles *C. paramoorei* Gardner (Ms.) from the Chipola marls, Florida. *C. paramoorei* has a more inflated body whorl and possesses slightly heavier ribs, especially on the earlier whorls—otherwise it is very similar. It less closely resembles *C. moorei* Guppy, a species described from the Bowden marls of Jamaica.

Occurrence.—Upper Miocene: Springvale, near Couva, Trinidad.

CANCELLARIA BULLBROOKI, new species

Plate 5, fig. 3

Shell small, rather slender, strongly constricted at the suture and consists of two and one-half nuclear and three and one-half post-

nuclear whorls. Nucleus obliquely situated, whorls smooth, inflated, rapidly enlarging and slightly tabulated below the suture. Postnuclear whorls distinctly set off from the nuclear whorls, both axially and spirally sculptured, whorls strongly shouldered anteriorly and posteriorly. Axial sculpture of strong, slightly retractive, rounded, intrasutural ribs (eighth on the penultimate whorl). Spiral sculpture of (two on the first whorl and three on the second whorl) wide-spaced cords overrunning the axials with equal strength and occupying the periphery of the whorl; on the base and the canal, there are 11 of these major spirals; aside from these major spirals, there are two spiral threads on the slope below the suture on the penultimate whorl and three on the body whorl. Aperture wide and slightly oblique; outer lip with a strong varix bordering the margin, within ornamented with six tubercles situated a little below the margin; inner lip biplicate, the posterior plication much stronger.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352663) measures: Altitude 7.3 mm.; greatest diameter 4 mm.; length of aperture 3 mm.; width 1.6 mm.

The species is represented by a single specimen. I find no close relative to this new species. The species is named in honor of J. A. Bullbrook, the collector.

Occurrence.—Middle or lower Miocene: Guaico-Tamana Road, 2 miles east of mile 13 from junction with Eastern Main Road, Trinidad.

Genus PSEUDOLIVA Swainson

PSEUDOLIVA GUPPYI, new species

Plate 5, fig. 6

Shell subovate, solid, rather low spired, one-fifth length of shell, with four and one-half whorls in all. Last two and one-half whorls quite strongly shouldered a little nearer the lower suture, behind which the whorls slope rather steeply to the suture and in front are nearly vertical. The upper whorls are rounded in outline. Suture loosely appressed on the early whorls but grooved on the later whorls. Apical one and one-half turns, smooth, polished, and semihemispherical in outline. Sculpture on subsequent whorl begins with very fine punctostriate spiral threads overspreading the first whorl and lying behind the shoulder on the two remaining whorls. Broad and elongate tubercles occupy the periphery of the last two whorls. Body whorl marked with a distinct sulcus which encircles the whorl shortly below the upper lip commissure on the body wall to the lower part of the outer lip. About twelve spiral plicate bands lie below this sulcus. In addition to the above sculpture ornamentations, there are rather indistinct, raised, narrow bands lying between the shoulder and the sulcus on the body whorl, and irregular growth lines crossing

the whorls, being more prominent on the last whorl. Aperture about one-half the length of the shell, semiovate in outline; its anterior extremity forms a wide, short, rounded, reflected canal emarginating the anterior extremity. A small chink is behind the smooth calloused columella.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352664) measures: Altitude 10.5 mm.; greatest diameter 6.5 mm.; length of aperture 6.5 mm.

The genus is found in the Recent fauna along the western coast of Africa.

Occurrence.—Upper Miocene: Caroni County, Springvale, near Couva.

Genus ANCILLA Lamarck

ANCILLA LAMELLATA (Guppy)

Ancillaria lamellata Guppy, Geol. Soc. London, Quart. Journ., vol. 22, 1866, p. 579, pl. 26, fig. 9.

Type locality: "Lower Miocene, Manzanilla, Trinidad, Guppy, 1866." There are in the United States National Museum (Cat. No. 115568) four specimens designated as types.

This species is separated from *Ancilla paralamellata*, new species collected from the Brasso beds by its more evenly conic spire and by the undulating spirals on the early whorls. I find no close relative to this species in outside deposits. Two specimens of this species were collected from Manzanilla coast, station 9197, by J. A. Bullbrook.

ANCILLA PARALAMELLATA, new species

Plate 5, figs. 2, 7

? *Ancilla lamellata* Maury (? in part), Bull. Amer. Paleont., vol. 10, no. 42, p. 197, 1925.

Shell rather small for the group, semiovate, highly polished, spire acuminate, slightly depressed behind the anterior suture, larger cotype probably with about six whorls. Entire shell covered with a thin wash of callus except for a narrow area encircling the lower half of the body whorl, beginning opposite the pillar and extending to the margin of the outer lip; a heavier callus on the body whorl marginates the uncalloused area and extends parallel with the axis of the whorl from the suture to the upper margin of the aperture. Nucleus apparently consists of about one whorl. Spirally sculptured mainly on the spire whorls—early whorls of about two or three striae separated by slightly raised areas; on the later whorls the striae increase in number and the interstices flatten out. Behind

the pillar is the usual deep, rounded-bottom furrow, behind which are two calloused plications; the margin of the posterior plate marks the lower boundary of the uncalloused area; a spiral stria is near the lower part of the uncalloused area. Aperture wide, elliptical, with a posterior chink at the commissure of the outer lip and body whorl; outer lip arcuate; pillar concave and twisted, provided with a thin, sharp, high, and oblique plication above; base of pillar splayed and scored with 12 to 15 sulci. Anterior canal, short, rounded, wide, and deep.

Dimensions: Larger cotype (U. S. Nat. Mus. Cat. No. 352667) measures: Altitude 27.5 mm.; greatest diameter 12 mm.; length of aperture 12 mm.

The new species here described is very closely related to *A. lamellata* Guppy, but it has less undulating spiral bands on the earlier whorls than Guppy's species.

Type locality: 9212. One mile south of Brasso, Trinidad, in flood-wash.

ANCILLA CARONIANA Maury

Plate 5, fig. 4

Ancilla caroniana Maury, Bull. Amer. Paleont., vol. 10, no. 42, p. 198, pl. 33, figs. 4, 10, 12, 1925.

Shell of medium size, semiovate, solid, spire moderately acuminate and about as long as aperture, slightly grooved at the suture, about six whorled. Surface of shell with a thin wash of callus except for a banded area encircling the lower half of the body whorl, beginning opposite the pillar and extending to the margin of the outer lip; a heavier longitudinal callus on the body whorl marginates the uncalloused area and unites with the posterior extremity of the columellar plate just below the posterior commissure of the aperture. Apical whorl rounded; following whorls gradually and evenly enlarging with a low shoulder behind the shallowly grooved suture. Spire sculptured only with two or three spiral striae on the scarp behind the suture. Aperture elliptical, a little longer than wide; outer lip arched, moderately thin; pillar a little longer than body of the shell, concave, twisted, provided with a strong plication, decidedly oblique within, margin backward curved and unites with the body wall below the posterior commissure of the aperture; base of pillar splayed and scored with about four striae. A prominent, deep, furrow is between the columellar plate and the body wall, below it is shallow, rounded and twists with the pillar and extends nearly to its anterior end. Behind the pillar, is the usual deep, rounded-bottom furrow, behind which are two heavy plicated bands separated by a narrow furrow extending anteriorly to the siphonal

emargination; the upper margin of the posterior plication marks the lower boundary of the uncalloused area; a spiral stria is near the lower part of the uncalloused area. Anterior canal short, wide, rounded, and deep.

Dimensions: Figured specimen (U. S. Nat. Mus. Cat. No. 352665) measures: Altitude 41 mm.; diameter 18 mm.; length of aperture 19 mm.; diameter about 8 mm.

The species has a general resemblance to *Ancilla shepardi* Dall, from the "silex bed" of the Tampa formation of Florida, but it is a heavier shell and has a greater apical angle than Dall's species. Although apparently related to the Jamaican species, *A. pinguis* Guppy, it is easily separated. The Jamaican species is a smaller shell and is roundly excavated at the suture. Guppy reports "*Ancillaria lamellata*" Guppy from Springvale.[11] If his form is the same as in our collection from Springvale, it was wrongly identified with his species from Manzanilla.

Occurrence.—Upper Miocene: Springvale, near Couva, Trinidad.

ANCILLA CARONIANA Maury, subspecies SPRINGVALENSIS, new subspecies

Plate 5, fig. 5

There are two specimens from station 9195 and several specimens from Montserrat, Trinidad (Guppy), deposited in the United States National Museum which appear to be a subspecies of *A. caroniana.* The Montserrat specimens are labelled *Ancillaria glandiformis* Lamarck. The shell is shorter and stouter and the whorls more inflated than *A. caroniana*, otherwise it is very similar.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352666) measures: Altitude 35 mm.; greatest diameter 17 mm.; length of aperture 19 mm.; width about 8 mm.

Type locality: 9195. Springvale, near Couva, Trinidad.

Occurrence.—Upper Miocene: Montserrat, Trinidad (U. S. Nat. Mus. Cat. No. 115566).

ANCILLA BRASSICA Maury

Ancilla brassica MAURY, Bull. Amer. Paleont., vol. 10, no. 42, p. 199, pl. 33, figs. 1, 8, 9, 1925.

There are in the United States National Museum two specimens collected from Guaico-Tamana Road, 2 chains east of mile 13 from junction with eastern main road that compare with figure 9.[12]

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[11] Agr. Soc. Trin. and Tobago Proc., vol. 10 (Paper 440), p. 452, 1910.

[12] Figures 1 and 8 appear to represent two different forms and may represent two different species.

Genus MARGINELLA Lamarck

MARGINELLA (FABA) BULLBROOKI, new species

Plate 5, fig. 1

Shell small, solid, stout, semibiconic, highly polished, prominently axially sculptured, and three and one-half whorled. Spire less than one-fourth length of shell, broadly conic; last whorl gradually sloping from the peripheral shoulder to the broad base. Apical whorl smooth, bluntly rounded and partly concealed by callus. Suture of following whorls appressed and overlapping the preceding whorl nearly to the periphery; suture bordered below by a faint spirally-sculptured, wide, raised, slightly anteriorly-depressed, nearly flat plication, below which the shoulder steeply ascends. Axial sculpture of about twelve strong, rather sharp, triangular ribs, extending from the base of the shoulder behind to the suture on the spire whorls and forward on the body whorl nearly to the anterior extremity. Aperture moderately narrow, linear, shallowly channeled posteriorly, rounded and slightly expanded at the canal; outer lip with a prominent varix, inner margin ornamented with about nine denticles—denticles reduced at either extremity; pillar provided with four blunt-edged plications, the posterior two nearly transverse, anterior two oblique and the anterior one marginates the canal and joins the lip-varix.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352648) measures: Length 4.3 mm.; greater diameter 2.7 mm.; length of aperture, 3.4 mm.

The new species is unique. In a general way it is similar to a recent species *Marginella faba* Linnaeus from Senegambia, west coast of Africa. This very interesting species is named in honor of the collector, J. A. Bullbrook.

Occurrence.—Middle or lower Miocene: In flood-wash, 1 mile south of Brasso.

MARGINELLA (FABA) BRASSOËNSIS, new species

Plate 6, fig. 4

Shell small, polished, prominently axially sculptured, four whorled. Spire high, about one-third length of shell, whorls moderately inflated; body whorl inflated, roundly shouldered in front of the suture and evenly sloping to the base. Apical whorl smooth, short and bluntly rounded; following whorls with a low subsutural spiral line marginating the appressed suture, below which is the whorl constriction. Spire and body whorl axially sculptured by about thirteen sharp, vertical ribs, separated by rounded interspaces and extending

on the spire-whorls from suture to suture and on the body whorl forward to a little below the base. Aperture rather narrow, linear, posterior extremity rounded and commissure shallowly furrowed; anterior extremity well rounded; outer lip with a strong marginal varix, anchored posteriorly above the suture; inner margin ornamented with six denticles which do not enter beyond the varix; the posterior one is about one-fifth of the margin length from the end and about the same distance from the following anterior one, the others are closer-spaced and slightly reduced in size anteriorly. Pillar provided with four equal-sized and equally-spaced plications—the posterior two transverse and the anterior two oblique.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352649) measures: Length 3.5 mm.; greatest diameter 1.8 mm.; length of aperture 1.8 mm.

Type locality: Station 8302, in flood-wash, Caroni County, Montserrat Ward, 1 mile south of Brasso.

The new species here described differs from *M.* (*Faba*) *bullbrooki*, new species, in having a much longer spire and fewer denticles along the inner margin of the outer lip.

Occurrence.—Middle or lower Miocene: 9212, (?) 9027 (one imperfect specimen).

MARGINELLA GUPPYANA, new species

Plate 6, figs. 1, 2, 3

Shell of moderate size, pyriform, spire short and acuminate, about four whorled. Suture appressed. Whorls marked by a spiral stria below and near the suture. Surface of body whorl slightly depressed behind the rounded shoulder and marked by wide-spaced, axial ridges extending from the spiral stria forward to the periphery of the whorl. On smaller specimens assigned to this species, these ridges extend nearly across the body whorl; the interspaces on the spire slope are deeply excavated. The posterior end of the outer lip is a little higher than spire and its margin is anchored to the spire by a wash of callus; margin arcuate and bordered by a strong lip-varix. Columella medially concave and provided with four strong plications—posterior two transverse and terminating farther within, anterior two oblique and extending externally upon the prominent siphonal fasciole. The anterior one marginates the canal and fuses with the lip-varix.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352650) measures: Altitude 18 mm.; greatest diameter 14 mm.

I am unable to find a close relative to this new species.

Occurrence.—Middle or lower Miocene: St. Andrew County, Manzanilla Ward, Manzanilla coast.

MARGINELLA GUAICA Maury

Plate 6, fig. 12

Marginella guaica MAURY, Bull. Amer. Paleont., vol. 10, no. 42, p. 200, pl. 34, figs. 2, 4, 1925.

Shell of medium size, biconic, polished, and five whorled. Spire acuminate and about one-fourth the length of shell. Body whorl strongly shouldered below the suture, below which it slightly expands and then gradually tapers to the base. Apical whorl highly polished, bluntly rounded and partly concealed by callus. Last two whorls more inflated than the preceding and provided with a prominent, rounded, subsutural spiral band below which the shoulder is ornamented with short, rounded axials or folds. Aperture about three-fourths length of shell, medially a little wider, deeply notched posteriorly, and expanded at the anterior canal. Outer lip with a strong well-defined varix, ornamented within but not exending beyond the varix or over the posterior one-fifth of the margin, with 18 denticulations; pillar concave and provided with four grooved plates—the posterior two are nearly transverse and the anterior two oblique; the anterior one forms the margin of the canal and is continuous with the outer lip varix.

Dimensions: Figured specimen (U. S. Nat. Mus. Cat. No. 352656) measures: Length 13.6 mm.; greatest diameter 6.5 mm.; length of aperture, 9 mm.

The species resembles *M. sowerbyi* Gabb, a species occurring in both the Cercado and Gurabo formations of the Dominican Republic, but it differs from this species in being a more slender shell and possessing short axials at the shoulder of the spire below the suture.

Locality of figured specimen: 9219. Guaico-Tamana Road. 2 chains east of mile 13 from junction with Eastern Main Road.

Occurrence.—Middle or lower Miocene: 9212. 1 mile south of Brasso.

MARGINELLA SPRINGVALENSIS Maury

Plate 6, fig. 13

Marginella springvalensis MAURY, Bull. Amer. Paleont., vol. 10, no. 42, p. 200, pl. 34, figs. 10, 14, 1925.

Shell large, ovate, solid, and probably polished (surface corroded), and about four whorled. Spire acuminate and extending 5 mm. above outer lip; body whorl strongly and roundly inflated at the posterior third, and in front provided with a moderately thick wash of callus. Aperture 2 mm. wide above and 6 mm. below; outer lip slightly arcuate, outer margin with a wide and strong varix, inner margin smooth. Columella concave, provided with four equal-sized plications—anterior two are closer-set and more oblique. The lower extremity of the aperture is broken away.

Dimensions: Figured and only specimen (U. S. Nat. Mus. Cat. No. 352653) measures: Length 36 mm.; greatest diameter 21 mm.; length of aperture 30 mm.

The shape of the species recalls *Marginella aurora* Dall from the Chipola River, Florida, but the Chipola species has a narrower aperture and a denticulated outer lip along its inner margin.

Occurrence.—Upper Miocene: Springvale, near Couva, Trinidad, British West Indies.

MARGINELLA CALYPSONIS Maury

Plate 6, fig. 11

Marginella calypsonis Maury, Bull. Amer. Paleont., vol. 10, no. 42, p. 199, pl. 34, figs. 12, 13, 1925.

Shell of medium size, ovatecylindrical, solid, polished, and about four whorled. Spire low, extending 3 mm. above the outer lip, partly concealed by callus; body whorl on the dorsal side of the shell, ovate with the periphery at the posterior one-third of its length; in front, the shell is slightly flattened and covered by a thick wash of callus; on the left side this callus forms a low rounded shoulder, and posteriorly nearly overlaps the spire and then encircles the aperture and extends a little below the shoulder of the whorl. Aperture moderately narrow, linear, and a little wider below; outer lip nearly straight, outer margin with a strong, distinct varix, inner margin smooth. Columella slightly concave, provided with four rounded, nearly equal-sized plications—the posterior two are transversely placed, the anterior two oblique.

Dimensions: Figured specimen (U. S. Nat. Mus. Cat. No. 352654) measures: Length 20 mm.; greatest diameter 11 mm.; length of aperture 17 mm.

The nearest fossil ally to the species is *Marginella macdonaldi* Dall, a species recorded by Olsson,[13] who writes:

"This large Marginella is one of the most common and characteristic species of the Gatun beds of Costa Rica." *Marginella macdonaldi*, however, is a larger shell with a proportionately shorter spire and a more expanded aperture at the posterior extremity.

The nearest recent ally, and, indeed, a very similar species is *Marginella cincta* Kiener. *Marginella cincta* is a proportionately broader shell, and has a more abrupt and steeper shoulder on the body whorl.

Occurrence.—Upper Miocene: Springvale, near Couva, Trinidad, British West Indies.

MARGINELLA SOLITARIA MONTSERRATENSIS, new subspecies

Plate 6, figs. 5, 6

The new subspecies differs from *Marginella solitaria* Guppy[14] from the Ditrupa bed, Point-à-Pierre, Trinidad, in the following re-

[13] Bull. Amer. Paleont., vol. 9, p. 267, 1922.
[14] Proc. U. S. Nat. Mus., vol. 19, p. 308, pl. 29, fig. 14, 1896.

spects: The spire is a little longer and the apical whorl less truncate; the body whorl is more shouldered below the suture and more depressed at the posterior third; the outer lip possesses a stronger marginal varix, and the inner margin one more denticle at the anterior end. Otherwise the variety is very similar to Guppy's species, which may not be quite adult. The length of Guppy's type is 2.6 mm. and diameter is 1.6 mm.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352658) measures: Length 2.7 mm.; greatest diameter 1.6 mm.

Occurrence.—Middle or lower Miocene: In flood-wash, Caroni County, Montserrat Ward, 1 mile south of Brasso railway station.

MARGINELLA (CLOSIA) NITRINA, new species

Plate 6, fig. 7

Shell minute, broadly ovate, polished, maximum diameter about four-fifths of the length of the shell and falling a little behind the middle of the vertical axis; back of body whorl slightly depressed below the periphery. Aperture slightly longer than the body whorl both posteriorly and anteriorly, narrow, nearly vertical, expanding a little at either extremity; outer lip with a strong, marginal varix which surrounds the anterior and posterior extremities of the aperture and merges with the callus wash over the face of the body whorl; inner margin coarsely granulose. Columella with four equally spaced, externally papillate plications—anterior two stronger and more oblique, terminal one sharp and marginates the inner wall of the canal.

Dimensions: Type (U. S. Nat. Mus. No. 352652) measures: Length 2 mm.; greatest diameter 1.5 mm.

The new species resembles *Marginella* (*Closia*) *ovuliformis* Orbigny, a species reported from the Pliocene to Recent, but it is a proportionately shorter shell with a body whorl anteriorly more acuminate and is a more cypraeiform shell than Orbigny's species.

Occurrence.—Middle or lower Miocene: In flood-wash, Caroni County, Montserrat Ward, 1 mile south of Brasso.

MARGINELLA (CLOSIA) LACHRIMULA Gould ?

Plate 6, fig. 9

There are two specimens from station 9224, Caroni County, Springvale, near Couva, that are somewhat corroded and incapable of exact specific determination. In all characters discernible, they compare with "*M.* (*Gibberula*) *lachrimula*" Gould,[15] a species that has been reported from the Miocene to Recent, especially abundant in the latter.

The larger and better preserved specimen (U. S. Nat. Mus. Cat. No. 352655) measures: Altitude 3 mm.; greatest diameter 2.1 mm.

[15] Boston Soc. Nat. Hist. Proc., vol. 8, p. 281, 1862.

MARGINELLA (GIBBERULA) TRINITATENSIS, new species

Plate 6, fig. 8

Shell small, ovate-cylindrical, solid, polished; spire about 0.2 mm. higher than outer lip; body whorl marked with microscopic bands (color ?), and a prominent rounded sulcus about 1 mm. from the anterior end. A heavy wash of callus overruns the spire and extends forward over the face of the body whorl to the anterior sulcus. Aperture narrow, linear, with a reflected anterior canal which emarginates the base of the whorl. Outer lip nearly vertical, margin slightly inflected medially, moderately curved in below and reflected above; serrated within below the margin. Columella provided with a strong oblique plication below the sulcus, and four weaker, equally spaced, transverse plications above. Lower border of inner lip provided with a thin, nearly erect plication.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352657) measures: Length 4 mm.; greatest diameter 2.3 mm.

Not all the specimens assigned to this species show spiral bands, probably due to the thickened porcelainlike layer and enamel. The nearest fossil ally to the new species appears to be *Marginella cercadensis* Maury, a species occurring in the Cercado formation of the Dominican Republic. The Dominican species, however, has a larger shell and has a much more expanded outer lip.

Occurrence.—Middle or lower Miocene: In flood-wash, Caroni County, Montserrat Ward, 1 mile south of Brasso.

MARGINELLA (PERSICULA) PROPEOBESA, new species

Plate 6, fig. 10

Shell ovate, rather fragile, posterior extremity well rounded, periphery at the posterior third of length, spire about 1 mm. higher than the margin of the outer lip. Spire whorls concealed by callus; number of whorls indeterminable; body whorl with a callus ridge overrunning the spire and extending parallel with and external to the aperture over the front of the body whorl for half its length; aperture moderately wide, arcuate and slightly expanding anteriorly with a recurved, short, rather wide anterior canal; outer lip arcuate, margin broken away. Columella convex, ornamented with eight plications, the posterior six transverse, equally spaced, gradually enlarging anteriorly and extending posteriorly over one-half the length of the columella, following plication much stronger, slightly biplicate and overruns the pillar externally, anterior one somewhat smaller, oblique, and marginates the canal.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352651) measures: Length 10 mm.; greatest diameter 7 mm.

The specimens from Montserrat are more mature than the Springvale specimen—the outer lip is entire, revealing a moderately strong

margin-varix and a serrated inner lip. The Montserrat specimens are mentioned [16] by Dall who states "In looking over the Guppy collection, now in the National Museum, I find a species from Cumana, labeled *M. coniformis*, but which can not be distinguished from *M. cincta* Kiener (No. 115599, U.S.N.M.); and another similarly named from Montserrat, Trinidad, which is a *Persicula*, closely related to *P. obesa*, Redfield."

The new species here described is very closely related to *M.* (*Persicula*) *arcuata* Guppy described from "Ditrupa bed, Pointapier, Trinidad," but that species though it may be an immature specimen, is a proportionally wider shell and possesses an outer lip with lirae far within its inner margin.

The closest fossil ally is *M. gravida* Dall, a species described from the Caloosahatchee formation (Pliocene) of Florida. The closest recent ally, *M. obesa* Redfield, has a more sloping posterior shoulder than the new species.

Marginella (*Persicula*) *couviana* Maury [17] is closely related to the new species but Maury's species has fewer plications on the columella.

Type locality: Station 9195. Springvale, near Couva.

Occurrence.—Upper Miocene: Montserrat, Trinidad (Guppy), (U. S. Nat. Mus. Cat. No. 115600).

Genus MITRA Lamarck

MITRA LONGA Gabb var. COUVENSIS Maury

Plate 7, figs. 9, 11

Mitra henekeni SOWERBY, Guppy, Scient. Assn. Proc., Trinidad, p. 160, 1867; Agr. Soc. Trinidad and Tobago, vol. 10, Society Paper No. 440, p. 452 and p. 454, 1910.

Mitra longa GABB var. *couvensis* MAURY, Bull. Amer. Paleont., vol. 10, no. 42, p. 203, pl. 35, figs. 1, 4, 1925.

Unfortunately the specimen is not entire—three or more of the early whorls and the extremity of the canal are missing. The spire is moderately acuminate and the body whorl much longer than the spire. Whorls convex in outline, and constricted at the excavated sutural area. Sculpture on the spire whorls of three to four, sharp, narrow, well-separated raised, primary spiral lines, intercalated with three to four secondary spirals which are axially crossed by growth lines of about equal strength, giving the area a cancellated appearance. Last whorl similarly sculptured, having 16 primary spirals intercalated with 3 to 4 secondary ones. Aperture apparently about one-half length of shell. Columella with five oblique folds, the

[16] U. S. Nat. Mus. Proc., vol. 19, p. 310, 1896.

[17] Bull. Amer. Paleont., vol. 10, no. 42, p. 202, pl. 34, fig. 11, 1925.

posterior one strongest and the following ones gradually diminishing in size.

Dimensions: Figured specimen (Cat. No. U. S. Nat. Mus. 352659) measures: Length 55 mm.; greatest diameter 15 mm.

Locality figured specimen: 9195. Caroni County. Couva Ward, Springvale, near Couva. J. A. Bullbrook, collector.

The nature of the sculpture of the variety differs from both that of *Mitra henekeni* and *Mitra longa* Gabb. It has more folds on the columella than *M. henekeni*. Perhaps it is closer related to *M. longa* than *M. henekeni*, but it is a much stouter shell than that species.

Occurrence.—Upper Miocene: "Savanetta" (Guppy), U. S. Nat. Mus. Cat. No. 11595, labeled "*Mitra henekeni* Sow."

Genus VEXILLUM Bolten

VEXILLUM BRISTOLI (Maury)

Plate 8, fig. 2

Turricula bristoli Maury, Bull. Amer. Paleont., vol. 10, no. 42, p. 205, pl. 35, fig. 5, 1925.

Shell subfusiform, solid, moderately stout, turrited, last whorl a little longer than spire, with one and one-half nuclear and six postnuclear whorls. Nucleus smooth, apical turn small, succeeding one slightly inflated and much larger. Postnuclear whorls gradually enlarging, shouldered adjacent to and below the distinct suture. Axially sculptured with about fourteen nearly vertical, rounded and smooth ribs, extending from suture to suture over the spire whorls and continuing weaker over the canal on the last whorl. Spirally sculptured with impressed lines (six on penult whorl) lying in the interaxial valleys, separated by square-topped interspaces of about equal width. Over the canal, three to four spirals are wider spaced and stand out in relief. Aperture rather narrow. Canal short. Outer lip sculptured within with seven slender, keeled, spiral lines. Columella with four plications, beginning a little above the center of the aperture, successively diminishing in size anteriorly. A single plication is on the body wall just below the commissure of the outer lip.

Dimensions: Figured specimen (U. S. Nat. Mus. Cat. No. 352660) measures: Altitude 7.5 mm.; greatest diameter 2.6 mm.; length of aperture 3 mm.

The species is a smaller, stouter, and more turrited shell than the species *Vexillum tortuosellum* (Pilsbry and Johnson) described from the Dominican Republic.

Mitra barnardensis Maury from the Chipola marl member of the Alum Bluff formation of Florida belongs in this same group. It is a larger shell with more acuminate spire than the species here described.

Occurrence.—Middle or lower Miocene: In flood-wash, Caroni County, Montserrat Ward, 1 mile south of Brasso.

Genus SOLENOSTEIRA Dall

SOLENOSTEIRA SEMIGLOBOSA Guppy

Solenosteira semiglobosa Guppy, Agr. Soc. Trinidad and Tobago, Proc., vol. 11, 1911, p. 200, pl. 2, figs. 5, 6.

Solenosteira semiglobosa Maury, Bull. Amer. Paleont., vol. 10, no. 42, p. 209, pl. 36, fig. 1, 1925.

This species is more closely related to *Solenosteira vaughani* Dall, a Miocene species of Coe's Mill Run, Florida, than *S. mengeana* Dall, a Pliocene species from Caloosahatchee River, Florida. However, it is a much larger form and more globose in outline than either of these species. In a general way, it resembles *S. anomala* Reeve of the West Coast ranging from Magdalena Bay to Panama, but that species has a much higher spire and more angled whorls. There is one specimen in our collection from station 9195, Springvale, near Couva, that agrees with Guppy's figures.

Genus PHOS Montfort

PHOS TRINITATENSIS, new species

Plate 7, fig. 5

Shell rather slender, solid, spire one-third length of last whorl, consisting of about two smooth convex and constricted nuclear and six moderately inflated and gradually enlarging postnuclear whorls. Suture of postnuclear whorls flexuous and close-fitting. Axial sculpture of postnuclear whorls of (seven on the penultimate and eight on the last whorl) strong, rounded ribs extending forward on the last whorl to the siphonal canal. Aside from these, there is one on the early whorls and increasing to two on the later whorls small axials between the major ribs, being nodulous at the intersection with the spirals. Spiral sculpture of (about six or seven on the spire whorls and fifteen on the last whorl) keeled, raised, backward-reflected, prominent primary lines overrunning the axials and valleys with about equal strength. Medially between these, there is a very fine spiral thread. Outer lip marked internally with 11 long, entering, sharp lirae. Columella biplicate at its lower extremity. Siphonal fasciole well developed, marked off behind by a groove, and sculptured with five spirals.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352669) measures: Altitude 22 mm.; greatest diameter, 11 mm.; length of aperture 10 mm.

The new subspecies differs mainly from *Phos semicostatus* in having strong axials on the body whorl and a longer canal. *Phos fasciolatus* Dall appears to be a distinct species and not "a form or variety" of *P. costatus* as stated by Pilsbry.[18] Dall's species has a different type of sculpture and nucleus.

Type locality: Station 9219, Guaico-Tamana Road, 2 chains east of mile 13 from junction with Eastern Main Road.

Occurrence.—Middle or lower Miocene: In flood-wash, 9212 (var.); 1 mile south of Brasso.

PHOS BULLBROOKI, new species

Plate 7, fig. 4

Shell small, solid, turrited, with acute spire, seven whorled including three nuclear whorls. Nuclear whorls porcellaneous, smooth except for a faint spiral below and near the suture, constricted, and shouldered below the suture. Apical turn minute, third one large. Following whorls strongly shouldered and excavated below the flexuous and moderately appressed suture. Axial sculpture of (11 on the penultimate and 8 on the body whorl) strong, rounded ribs, projecting behind over the subsutural sulcus and extending forward on the spire whorls to the suture and on the body whorl to the base. A small axial, nodulous at the intersection with the spiral, lies in the major interaxial valleys. Spiral sculpture of (7 on the penultimate whorl and 17 on the last whorl and canal) broadly-rounded, prominent lines, beginning above at the shoulder and continuing on the last whorl with equal strength over the axials and valleys forward to the carina of the siphonal fasciole. Faint secondary spirals intercalate the primary ones. Aperture about one-half the length of the shell; canal twisted. Margin of outer lip broken away. Columella with two folds—the posterior one is external and marks off the siphonal fasciole behind and the anterior one marginates the canal. Six spirals intercalate these folds.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352670) measures: Altitude 13.4 mm.; greatest diameter 7.3 mm.; length of aperture 6.5 mm.

The new species is based upon one specimen, perhaps immature, but it is well characterized. I am unable to find a very close relative to this new species.

Occurrence.—Middle or lower Miocene: Guaico-Tamana Road, 2 chains east of mile 13 from junction with Eastern Main Road.

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[18] Pilsbry, H. A., Revision of W. M. Gabb's Tertiary mollusca of Santo Domingo, Acad. Nat. Sci. Phila. Proc., pt. 2, p. 349, 1922.

Genus ALECTRION Monfort

ALECTRION BRASSOËNSIS, new species

Plate 7, fig. 3

Shell small, solid, acute, with three nuclear and three and one-half postnuclear whorls. Apical turn minute and papillose. Following nuclear whorls broadly conical, smooth, and inflated. Periphery of postnuclear whorls situated well forward and marginating the depressed presutural area of the following whorl; body whorl broadly rounded. Suture undulated and shallowly grooved. Axial sculpture of about twelve strong, rounded ribs extending from suture to suture on the spire and to the siphonal fasciole on the body whorl. Spiral sculpture of two to three close-set threads adjacent to and in front of the suture; four stronger, equally spaced threads extend forward to the periphery of the whorl; and two small threads lie within the depressed presutural area. Body whorl with about twelve major spirals. All spirals overrun the ribs and valleys with nearly equal strength. Aperture ovate. Outer lip with a strong varix; within, ornamented with five or six long lirae alternating near the margin with small denticles. Inner lip with a wash of callus, marked by two lirae on the body wall and roughened at its lower border. Canal short, reflected and slightly expanded anteriorly. Siphonal fasciole marked with six spirals.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352668) measures: Altitude 5.2 mm.; greatest diameter 3.4 mm.

Occurrence.—Middle or lower Miocene: In flood-wash, station 9212, Caroni County. Montserrat Ward, 1 mile south of Brasso. ? Occurs also at station 9197.

The new species differs from Maury's species, *Alectrion cercadensis*, in having fewer and stronger spirals on the body whorl. *Alectrion cercadensis* appears to be confined to the Cercado formation.

Genus METULELLA Gabb

METULELLA CARONENSIS, new species (? "STROMBINA COSTARICENSIS" Olsson, new subspecies)

Plate 7, figs. 7, 8

Shell solid, elongate-ovate, turrited, with a long attenuated upper spire; lower spire whorls nearly straight in outline, last whorl medially flattened above. Whorls probably about ten in number (early ones broken off) of which the first three are smooth, constricted at the suture, but not tabulated below and form an attenuated upper spire. Following whorls tabulated below the suture. Axial sculpture precedes the spiral and consists, at the initiation,

of faint axials and on the following whorls of (fifteen to seventeen on the penultimate whorl) moderately strong, slightly protracted ribs extending across the spire whorls and to the basal shoulder on the body whorl. Spiral sculpture of equal strength to axial and consists of slightly rounded, narrow cords, four to five in number on the spire whorls and fifteen on the body whorl and canal, being weakly nodulous at the intersection with the ribs. Outer lip broken away. Inner lip apparently bearing a callus. Columella medially enlarged, tapering below and bearing oblique cords.

Dimensions: Cotypes (U. S. Nat. Museum Cat. No. 352672) measures: Specimen A (with better preserved upper whorls), altitude 16.5 mm.; greatest diameter 6 mm. Specimen B, altitude 14.5 mm.; greatest diameter 6 mm.; length of aperture 6 mm.

The description and figures of *Strombina costaricensis* Olsson from the Gatun formation, Headwater of Middle Creek, Costa Rica, appear to match closely the Trinidad form. However, the diameter of Olsson's species is proportionately greater and the spirals weaker.

Occurrence.—Middle or lower Miocene: In flood-wash, Caroni County, Montserrat Ward, 1 mile south of Brasso.

Genus STROMBINA Mörch

STROMBINA WALLI, new species

Plate 8, figs. 5, 7

Shell small, solid, with a moderately short spire and a broad body whorl, eight whorled. Nucleus large, smooth, broadly conical, whorls convex and weakly constricted at the suture. Following whorls tabulated below the suture, spire whorls nearly straight in outline. Axial sculpture only on the three postnuclear spire whorls of (about twelve on the penultimate whorl) indistinct, rather broad axials, being more prominent at the base of the whorl. On some specimens, the axials are almost indiscernible. Last whorl smooth and flattened dorsally between a broadly rounded ridge on the left side and the very large outer lip. Aperture narrowly ovate, deeply incised behind with a short reflected anterior canal. Outer lip heavy, depressed behind the margin of facial surface and provided with seven denticles within; upper ones strong, lower ones very weak. Inner lip heavily calloused and provided with four denticles along the columellar border. Base of body whorl and columella spirally sculptured with about twelve cords.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352671) measures: Altitude 6 mm.; greatest diameter 3.4 mm.; length of spire 2.2 mm.; length of aperture 3 mm. A larger specimen with a missing outer lip

measures: Altitude 7.5 mm.; length of spire 2.7 mm.; length of aperture 4.2 mm.

The new species very closely resembles *Strombina chiriquiensis* Olsson from the Gatun formation, Water Cay, Panama. It differs mainly from that species in having weaker axials on the spire whorls. Its closest ally among the Dominican fauna is *Strombina pseudohaitensis* Maury, Cercado formation. but this species is larger, has heavier radials on the spire and has a weak spiral ridge directly below the suture.

The new species is named in honor of G. P. Wall, a pioneer geologist in Trinidad.

Occurrence.—Middle or lower Miocene: In flood-wash, Caroni County, Montserrat Ward, 1 mile south of Brasso.

Genus TYPHIS Montfort

TYPHIS SAWKINSI, new species

Plate 2, fig. 11

Typhis linguiferus Maury (not of Dall), Bull. Amer. Paleont., vol. 10, no. 42, p. 214, pl. 36, figs. 4, 5, 1925. Identification not certain.

Shell small, solid, fusiform, strongly axially sculptured. with five remaining whorls, tip broken off. Early whorls carinated, later strongly shouldered below the suture. Axial sculpture of (four on the penultimate whorl and five including the strong lip varix on the body whorl) strong varices alternating with weaker axials bearing at their summits moderately strong, protractive tubes. The varices are very strong on the three anterior whorls, offset to the left at the suture and overlap the preceding whorl, terminating at the base of the intervarical tube and lying between the varix and the rib. Between the varices the deep recessed suture is revealed. Each varix bears on its right margin and directly over the suture a short tube. The intervarical ribs extend on the spire whorls from the shoulder to the following suture, and on the last whorl to the base. A few minute axial growth lines overrun the surface. Aperture elongate-ovate, bordered by a raised rim. Anterior canal curved to the right and on the left side strengthened by three anterior-converging varices.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352673) measures: Altitude 15 mm.; greatest diameter 7.5 mm.

This species recalls *Typhis gabbi* Brown and Pilsbry from the Gatun formation, Panama, but that species possesses wrinkled and pitted sculpture markings on the last whorl not seen on the new species. The new species is named in honor of J. G. Sawkins, a pioneer geologist in Trinidad.

Occurrence.—Middle or lower Miocene: Guaico-Tamana Road, 2 chains east of mile 13 from junction with Eastern Main Road.

Genus CYPRAEA Linnaeus

CYPRAEA TRINITATENSIS, new species

Plate 8, fig. 10

Shell solid, subelliptical and smooth. Spire broadly conic, consisting of three inflated whorls, apical turn broken off. Aperture narrow above and wide at the anterior end. Teeth equally prominent on both lips, rising vertically from within. There are about 25 teeth on the outer lip. Anterior canal narrow, fortified above by a single tooth on either side. The specimen is preserved as a cast. The spire as now revealed may have been concealed by enamel, but there is no indication of this.

Dimensions: Type and only specimen (U. S. Nat. Mus. Cat. No. 352686) measures: Length 39 mm.; lateral diameter 21 mm.; ventral diameter 16 mm.

The new species in general aspect recalls *C. exanthema* Linnaeus, a recent species, but Linnaeus's species has a pinched or contracted anterior lateral extremity, while the new species has a broader and less attenuated anterior region.

Occurrence.—Lower Miocene; Station 8299 (loc. 3), Cumuto Road, 17 miles from Eastern Main Road, Trinidad.

Genus MODULUS Gray

MODULUS TAMANENSIS Maury

Plate 7, figs. 1, 2

Modulus tamanensis MAURY, Bull. Amer. Paleont., vol. 10, no. 42, p. 237, pl. 40, figs. 2, 3, 1925.

Shell large and strong with about one smooth, broadly coiled nucleus and seven prominent spirally sculptured subsequent whorls; spire whorls broadly conic; body whorl slightly compressed above the periphery; base subconic and full. Spire sculpture of six, high, thin, marginally reflected and undulated spirals, the posterior one being strongest and overhangs the suture; base with eight similar subequal spirals. Surface of whorl crossed by retractive growth lines which overrun the summits of the spirals, crenulate them on the later whorls and produce a cancellate ornamentation on the early whorls. Aperture subquadrate; outer lip sharply lirate within, harmonizing with the spiral sculpture; body wall and lower columella with a moderately heavy wash of callus; columella short, bearing a thin revolving lamella which forms the left side of the anterior, deep but narrow channel. A small chink is behind the columellar callus.

Dimensions: Figured specimen (U. S. Nat. Mus. Cat. No. 352686) measures: Altitude 29 mm.; maximum diameter 19 mm.

Locality of figured specimen: Station 9219. Guaico-Tamana Road, 2 chains east of mile 13 from junction with Eastern Main Road.

The species is closely related to *Modulus wilcoxii* Dall from the Chipola marl member of the Alum Bluff formation, Florida, but it differs mainly from Dall's species in having stronger spiral sculpture and lacking the blunt duplex and undulating carina at the shoulder of the body whorl. When compared with *M. basileus* (Guppy) from the Bowden marls of Jamaica, that species is found to have much weaker spirals over the middle part of the whorl and a proportionally heavier carina on the basal whorl.

Occurrence.—Lower or middle Miocene: Nariva County, Charuma Ward, Machapoorie Quarry.

Genus CAECUM Fleming

CAECUM PROPEREGULARE, new species

Plate 8, fig. 6

Shell small, solid, strongly curved, moderately tapering; periphery at anterior one-fifth of length; anterior extremity smooth and contracted, sloping forward from the periphery. Sculpture of (about 24) rounded, close-set threads, separated by shallow stria; posterior annulation a little wider and more prominent and marginating the posterior end. Plug not extending much above the margin of the shell; mucro small, situated at the margin on the convex side.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352675) measures: Length 1.5 mm.; diameter of anterior end 0.3 mm.; diameter of posterior end 0.2 mm.

The new species belongs to the group of *Caecum regulare* Carpenter, but that species has sharper spiral annulations. It more closely resembles an unpublished new species from the Shoal River marl member of the Alum Bluff formation of Florida.

Occurrence.—Middle or lower Miocene: In flood-wash, Caroni County, Montserrat Ward, 1 mile south of Brasso Station.

Genus VERMICULARIA Lamarck

VERMICULARIA, species

There are specimens of the Genus *Vermicularia* from Springvale, near Couva, station 9195, that resemble *Vermicularia eburneus* Reeve, a Recent species of the west coast geographically ranging from San Diego, Calif., to Panama, but the material at hand is hardly adequate for specific determination.

Genus PETALOCONCHUS H. C. Lea

PETALOCONCHUS ALCIMUS, new species

Plate 9, figs. 2, 3, 4

Petaloconchus sculpturatus [not H. C. Lea] GUPPY, Agr. Soc. Trinidad Proc., vol. 10, p. 451, 1910. (In his list from Springvale.)

Petaloconchus sculpturatus, var. *domingensis* MAURY (not of Sowerby), Bull. Amer. Paleont., vol. 10, no. 42, p. 226, pl. 41, figs. 2, 4, 7, 1925.

Shell solid, strong, thick walled, and large. Early part of shell forms a loose and irregular spiral coil, which is angled with the succeeding part. The following part up to about an inch in length is more regularly spirally coiled, with gradually enlarging volutions. The terminal part is usually coiled but the turns are very irregular and loose. Whorl contour of the more regularly coiled part nearly straight, slightly depressed medially and carinated at its lower margin. The terminal tube is more rounded in outline. Sculpture on the earliest coils of wide spaced, incremental transverse riblets, and of two to three longitudinal lines being weakly nodulous at the intersection with the ribs. The sculpture on the following more regular coils not strong, consisting of incremental rugae and low longitudinal lines. The two internal laminae are high, rounded at the summits, and arched toward each other.

Petaloconchus sculpturatus H. C. Lea is a much smaller shell and possesses stronger and more beaded, longitudinal sculpture lines, the whorl contour on the more regular and closely coiled spire is more rounded than in the new species.

Type and locality (U. S. Nat. Mus. Cat. No. 352674) : Station 9195, Springvale near Couva, Trinidad.

Occurrence.—Upper Miocene: "Montserrat (Guppy), U. S. Nat. Mus. Cat. No. 115456, and "Corona series" (Guppy) U. S. Nat. Mus. Cat. No. 115457.

Genus TURRITELLA Lamarck

TURRITELLA GATUNENSIS CARONENSIS, new subspecies

Plate 8, figs. 12, 13, 14

Turritella gatunensis MAURY, Bull. Amer. Paleont., vol. 10, no. 42, p. 229, pl. 42, fig. 12, 1925.

The specimens assigned to this new subspecies largely consist of fragments, either of the early or later whorls of the shell. When the form of the new subspecies is compared with *Turritella gatunensis* Conrad it is found to be less attenuated, slightly more constricted and less roundly excavated at the suture, and the two primary spirals on the lower half of the whorl to be less distinct than on the latter species. The early whorls on both are very similar. The number of whorls is not known. The nucleus of the new subspecies

consists of one and one-half whorls; the apical turn is minute, the following much larger, smooth, and inflated. A low indistinct medial carina and minute spiral threads appear on the following whorl, becoming gradually stronger in ascending the spire. On the fourth whorl, another primary spiral appears at the base of the whorl. At first, this is weak but gradually strengthens and on the later whorls becomes nearly as strong as the medial one. On the anterior whorls, the two primary spirals continue but are not prominent. Four or five rather strong secondary spiral lines intervene behind the medial primary and the suture, two or three lie between the primary spirals and about two behind the suture; very fine tertiary spiral threads overrun the interspaces.

Cotypes (U. S. Nat. Mus. Cat. No. 352678).

Type locality: In flood-wash, station 9212, Caroni County, Montserrat Ward, 1 mile south of Brasso.

Occurrence.—Middle or lower Miocene; Stations 8302, 9215.

TURRITELLA MACHAPOORENSIS Maury

Plate 7, fig. 10

Turritella machapoorensis MAURY, Bull. Amer. Paleont., vol. 10, no. 42, p. 234, pl. 42, fig. 11, 1925.

Shell acuminate and solid, whorls medially compressed, suture very shallow and indistinct. Early whorls with a broad medial concavity, marginated above and below by a rounded raised cord, the lower being a little stronger and forming the periphery of the whorl. Another spiral, small at first but gradually increases in size in ascending the whorl until it equals in strength the one above, lies behind the suture. On the later whorls, the three primary spirals continue, the lower two becoming more prominent and the presutural one being a little stronger and forms the periphery of the whorl. Rather close-set, carinate spirals intervene the primary, about three lie between the suture and the following primary, three to four lie in the shallow concavity and one between the basal primaries. Very fine irregular spirals overrun the shell, being especially evident on the larger whorls. The anterior part of the specimen is broken away.

Dimensions: Figured specimen (U. S. Nat. Mus. Cat. No. 352680) measures: Length 29 mm.; greatest diameter 12 mm.

This species closely resembles *Turritella tampae* Heilprin from the "silex bed" of the Tampa formation of Florida. The upper spiral whorls on the latter species are more drawn out, the suture more distinct and interval between the basal cords smooth or feebly sculptured. The species also resembles *Turritella anguillana* Cooke from the Oligocene, Anguilla, but the latter species possesses a stronger paired basal spirals and less ornamentation above

them. A similar type of shell occurs at station 5853, Panama Canal Zone, apparently from the Culebra formation.

Locality of figured specimen: 9220, Nariva County, Charuma Ward, Machapoorie Quarry, Trinidad.

Occurrence.—Lower Miocene: 8299, Caroni County, San Rafael Ward, Cumuto Road, 17 miles from Eastern Main Road.

TURRITELLA CAPARONIS Maury

Plate 9, figs. 10, 11

Turritella caparonis Maury, Bull. Amer. Paleont., vol. 10, no. 42, p. 234, pl. 42, figs. 1, 2, 1925.

Shell strong, acute-conic, of eighteen whorls (estimated); nucleus decollate; whorls slightly convex in outline; sutural area shallow, roundly concave; suture close-fitting, distinct on earlier whorls and partly concealed on the later whorls by the preceding spiral ridge. Sculpture mainly of four equally spaced primary spirals of equal strength, save the presutural one, which is weaker, being lower-lying, rounded, finely spirally marked and projecting over the suture. The three other primary spirals begin on the earliest whorls as distinct, weakly beaded, fine, raised cords, but in ascending the whorl these gradually become more prominent, consisting of high, thin, denticulated, erect ridges, resembling the threads on a screw, the forward third forming the periphery of the whorl. Another beaded spiral lies near the upper base of the posterior ridge, faint on the early whorls but gradually increasing in strength in ascending the whorl. On the later whorls, a much finer spiral thread lies shortly below the suture. Weak, arcuate growth threads cross the spiral interspaces.

Dimensions: Synthesis of two specimens (U. S. Nat. Mus. Cat. No. 352681) measures: Length 28 mm.; greatest diameter 16 mm.

The species resembles *Turritella chipolana* Dall, from the Chipola marl member of the Alum Bluff formation, Florida. The species has four spirals on the earliest whorl, the Chipola species has three, and has much higher and thinner spiral ridges than the Chipola form.

Occurrence.—Lower Miocene: Station 8301 (loc. 5, F. W. P.), Nariva County, Charuma Ward, Machapoorie Quarry.

TURRITELLA MONTSERRATENSIS, new species

Plate 9, figs. 5, 6

Turritella altilira var. *tornata* Maury (part), Bull. Amer. Paleont., vol. 10, No. 42, p. 230, pl. 42, fig. 3, 1925. (Not *Turritella tornata* Guppy.)

The cotypes consist of the lower five whorls of an adult specimen and the lower three whorls of a young specimen, the nuclei of both are

broken off. Shell of medium size and solid; whorls loosely coiled, medially concave, and rapidly enlarging in ascending the spire. Suture deep. Spiral sculpture on the early whorls of two low, weakly nodulous cords bordering the upper and lower shoulder of the whorl and separated by a shallow, broadly rounded concavity marked within with two smaller, weakly nodulous spiral cords. Lower spire whorls spirally sculptured with two moderately high cords serrated at their summits and occupying the upper and lower third of the whorl; these cords are separated by a broad, shallow concavity marked with two secondary spirals. The upper primary spiral weakly coronates the whorl. Another low spiral lies behind the suture and forms behind it on the basal slope a narrow and shallow sulcus which becomes more prominent on the body whorl. On the body whorl, the two primary spirals are low and rounded and the median band is shallow: the surface is roughened by imbricated, flexuous growth structures which almost conceal the median spirals.

Dimensions: Larger cotype (U. S. Nat. Mus. Cat. No. 352682) measures: Length 39 mm.: greatest diameter 15 mm.

The new species resembles *Turritella altilira costaricensis* Olsson from Gatun formation, Upper Hone and Boucary Creeks, Costa Rica, but the primary spirals on Olsson's species are weaker than on the new species.

Occurrence.—Caroni County, Montserrat Ward, junction of Gran-Couva and Brasso-Tabaquite Roads.

TURRITELLA, species cf. T. ALTILIRA, var. CHIRIQUIENSIS Olsson

Plate 10, figs. 2, 5

Turritella altilira chiriquiensis Olsson, Bull. Amer. Paleont., vol. 9, p. 322, pl. 7, figs. 4, 8, 9, 14, 1922.

Turritella altilira var. *tornata* Maury (part), Bull. Amer. Paleont., vol. 10, no. 42, p. 230, pl. 42, figs. 4, 5. (Not *Turritella tornata* Guppy.)

The form compared with this variety in our collection consists either of young individuals or fragments of the lower whorl of adult specimens. It differs mainly from *Turritella altilira* (typical) in being a slightly less attenuated shell and having more delicate sculpture ornamentations, and spiral sculpture markings on the upper slope of the posterior spiral cord. Of all specimens of *Turritella altilira* examined, the summit of the posterior spiral cord on the adult whorls is posteriorly reflected and the presutural area in front of it is very weakly spirally sculptured or bare. The lower member of the posterior spiral when doubled is the last to appear and gradually increases in strength in ascending the whorl. Some of the Trinidad specimens show a double posterior spiral but the

anterior member is always stronger and originates first while the posterior one is borne upon the upper slope of the lower and is the last to appear. The median concavity is marked with about two beaded secondary spirals and by tertiary ones between and on either side of the secondaries. The two primary spirals are crenulated at their summits and in strength are about equal. The type of *Turritella tornata* Guppy from Cumana, Venezuela, may be a young individual. This differs mainly from my specimens in having a much weaker spiral thread on the upper slope of the posterior spiral and two within the median concavity.

Figured specimens: U. S. Nat. Mus.. Cat. No. 352676.

Occurrence.—Middle or lower Miocene: In flood-wash, 8302, Caroni County, Montserrat Ward, 1 mile south of Brasso; 9215, Caroni County, Montserrat Ward, Brasso railroad station, stream wash; 9219, Guaico-Tamana Road, 2 chains east of mile 13 from junction with Eastern Main Road.

TURRITELLA aff. T. PERATTENUATA PRAECELLENS Pilsbry and Brown

Plate 9, figs. 7, 8

Turritella perattenuata praecellens Pilsbry and Brown, Acad. Nat. Sci. Phila. Proc., vol. 69, p. 36, pl. 5, fig. 12, 1917.

Turritella altilira var. *tornata* Maury (part), Bull. Amer. Paleont., vol. 10, no. 42, p. 230. (Not *Turritella tornata* Guppy.)

There are several imperfect specimens that appear closely related to *T. perattenuata praecellens* Pilsbry and Brown from the Dominican Republic. They all possess two equally strong, crenulated primary spiral cords, the posterior one being double, with its posterior member being a little weaker. The median concavity is rather narrow and is usually spirally marked with one very fine thread. In the latter feature it differs from the Dominican form, as that is marked with several cords within the median concavity. These specimens tentatively compared with the Dominican species may prove to be distinct species when better material is procured but at present they hardly warrant a specific designation.

Occurrence.—Lower Miocene: Narviva County, Charuma Ward, Machapoorie Quarry; Figured specimens (U. S. Nat. Mus. Cat. No. 352677).

TURRITELLA PLANIGYRATA Guppy

Plate 9, figs. 1, 9

Turritella planigyrata Guppy, Sci. Assoc. Trinidad Proc., vol. 1, pt. 3, pp. 169–170, 1867, (described).

Turritella planigyrata Guppy, Geol. Mag. London, vol. 1, n. s., p. 408, pl. 18, fig. 5, 1874 (very poor figure).

Turritella planigyrata GUPPY, Geol. Soc. London, Quart. Journ., vol. 32, p. 519, 1876.

Turritella planigyrata GUPPY, Agr. Soc. Trinidad and Tobago, (Society Paper No. 444), vol. 10, p. 451, 1910.

Not *Turritella planigyrata* GUPPY, Maury, Bull. Amer. Paleont., vol. 5, p. 293, pl. 48 fig. 14, 1917.

Turritella planigyrata MAURY, Bull. Amer. Paleont., vol. 10, no. 42, p. 232, pl. 42, figs. 6, 7, 8, 1925.

"Conic cylindric, striate by fine spiral lines, whorls very slightly convex, the later ones nearly flat; aperture subquadrate. Caroni series, Savanetta. A very distinct species, remarkable for its almost entire want of ornamentation, and the flatness of its whorls. I have lately received another specimen of *Turritella* from Mr. LeRoy, which is more like *T. imbricata*" (Guppy 1867),

There are in the United States National Museum four specimens (U. S. Nat. Mus. Cat. No. 115626), Montserrat (Guppy), and one specimen (U. S. Nat. Mus. Cat. No. 115452), Caroni series, Savanetta (Guppy), designated as types. All of these bear the same specific characterization. In addition, there are five specimens in the collection from Springvale (station 9195), one of which represents the lower whorls of a specimen larger than any forms in Guppy's types.

None of the specimens possess the earliest whorls. The earliest whorls on the specimens at hand are slightly convex at the equator, gradually sloping to the upper and lower suture. In ascending the spire the whorls gradually flatten out and gently ascend from the upper part of the whorl to the base. It is quite probable that the very earliest whorls are medially carinate. The spiral sculpture is very unique, consisting of very narrow, flat-topped bands promiscuously alternating either with narrower bands or fine spiral lines. On the earlier whorls, these spirals are very close-set, separated by spiral striae but on the later whorls these intervals widen. On the earlier whorls, the sutural area is broadly concave, interrupted only by the small presutural spiral, but on the lower and adult whorls the preceding whorl weakly overhangs the lower suture. The base of the whorl is similarly sculptured, except for a narrow, roundly excavated furrow situated a little below the angled shoulder.

Dimensions: Larger specimen of Guppy's types (U. S. Nat. Mus. Cat. No. 115626) measures: Length—tip broken off—41 mm.; diameter 15 mm. The diameter of a larger specimen from station 9195 (U. S. Nat. Cat. No. 352679) measures 23 mm.

This species is very closely related to *T. cartagenensis* Pilsbry and Brown from the Republic of Colombia, South America, but the latter species has a slight concavity in the upper half of the larger whorls, and the spiral sculpture is a little more open than in Guppy's species.

The recent analogue is *T. broderipiana* Orbigny, a species on the west coast extending from the Gulf of California to Peru, but the recent species in general is more medially compressed on the later whorls than the Trinidad species.

TURRITELLA, species cf. T. ALTILIRA Conrad (Typical)

Turritella altilira CONRAD, Pacific R. R. reports, vol. 6, p. 72, pl. 5, fig. 19, 1857.
Turritella gabbi TOULA, Jahrb. kk. Geol. Reichsanstalt, p. 695, pl. 25, fig. 5, 1909.
Turritella altilira BROWN and PILSBRY, Acad. Nat. Sci. Phila. Proc., vol. 63, p. 358, pl. 27, figs. 2, 3, 1911.
Turritella altilira OLSSON (typical), Bull. Amer. Paleont., vol. 9, p. 322, pl. 17, figs. 6, 7, 1922.

There are a few poorly preserved specimens that appear to represent *Turritella altilira* (typical). When better specimens are procured they may prove closely allied species or a varietal form.

Occurrence.—Stations, (?) 9215, 8300, 9212.

Genus NATICA Scopoli

NATICA YOUNGI Maury

Natica youngi MAURY, Bull. Amer. Paleont., vol. 5, p. 299, pl. 49, figs. 11, 12, 1917.
Natica finitima PILSBRY and JOHNSON, Acad. Nat. Sci. Phila. Proc., p. 173, 1917 (described).
Natica youngi MAURY, Pilsbry, Acad. Nat. Sci. Phila. Proc., pl. 34, fig. 21, 1921.
Natica youngi MAURY, Bull. Amer. Paleont., vol. 10, no. 42, p. 239, pl. 40, fig. 4, 1925.

Occurrence in Trinidad, station 9195, Caroni County, Couva Ward, Springvale, near Couva.

NATICA CANRENA (Linnaeus)

Nerita canrena LINNAEUS, Syst. Nat., ed. 10, p. 776, 1758.
Natica canrena LINNAEUS, Gabb, Amer. Philos. Soc. Trans., vol. 15, p. 223, 1873.
Natica canrena LINNAEUS, Guppy, Geol. Soc. London Quart. Journ., vol. 32, p. 518, 1876.
Cf. *Natica cuspidata* GUPPY, Agr. Soc. Trinidad and Tobago Proc., vol. 11, p. 198, pl. 2, fig. 4, 1911.
Natica canrena (Linnaeus), BROWN and PILSBRY, Acad. Nat. Sci., Phila., Proc., p. 508, 1912.
Natica canrena (Linnaeus), MAURY, Bull. Amer. Paleont., vol. 5, p. 298, pl. 49, fig. 10, 1917.
Natica canrena (Linnaeus), PILSBRY, Acad. Nat. Sci. Phila. Proc., p. 386, 1921.
Natica canrena LINNAEUS, Olsson, Bull. Amer. Paleont., vol. 9, p. 327, pl. 16, fig. 9, 1922.
Natica canrena MAURY, Bull. Amer. Paleont., vol. 10, no. 42, p. 238, pl. 40, fig. 8, 1925.

Occurrence in Trinidad.—Station 9195, Caroni County, Couva Ward, Springvale, near Couva. Station 9196, Caroni County, Montserrat Ward, junction of Gran Couva and Brasso-Tabaquite Roads.

Station 9219, Guaico-Tamana road, 2 chains east of mile 13. Station 8302, Caroni County, Montserrat Ward, 1 mile south of Brasso railway station. Flood-wash (young). Station 9027, Caroni County, Montserrat Ward, Brasso-Gran Couva Road, 100–200 yards west of Brasso (young). (?), 9220, Nariva County, Charuma Ward, Machapoorie Quarry (casts).

Genus AMAUROPSIS Mörch

AMAUROPSIS TRINITATENSIS, new species

Plate 10, figs. 4, 6

Shell large, subovate, with four remaining whorls, early whorls decollate; spire high for genus with gradually enlarging whorls. Whorls inflated with a low posterior shoulder; suture, as indicated, narrow and shallowly depressed.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352684) measures: Altitude 45 mm.; greatest diameter 33 mm.

The new species resembles in outline specimens of an undescribed form from station 6894, Crocus Bay, Anguilla, whose fauna has been referred to the Oligocene.

The high spire of the new species with its gradually enlarging and low-shouldered whorls distinguishes it from *A. guppyi* (Gabb).

Occurrence.—Lower Miocene: Station 8299, Cumuto Road, 17 miles from the Eastern Main Road, Trinidad.

Genus CALLIOSTOMA Swainson

CALLIOSTOMA ATTRINA, new species

Plate 10, figs. 7, 8

Shell rather small, conic, with seven remaining whorls—nucleus missing; whorls convex; shoulder of body whorl narrowly rounded; sutural area depressed on later whorls. Spire whorls sculptured with about six strongly beaded, primary spirals and two to three scattered intermediate secondary beaded spirals or crenulated threads—a smaller beaded spiral precedes the suture. About fourteen primary spirals extend from the periphery of the body whorl across the base. Margin of outer lip broken. Aperture apparently subovate. A small chink lies behind the aperture.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352688) measures: Altitude 13 mm.; greatest diameter 12 mm.

Occurrence.—Lower Miocene: Station 8299, Cumuto Road, 17 miles from the Eastern Main Road, Trinidad.

CALLIOSTOMA RHOMBOTUM, new species

Plate 8, figs. 4, 8

Shell very small, conic, four and one-half whorled; whorls rapidly expanding, nearly straight in outline; sutural area distinct and open on spire whorls, indistinct on body whorl; base nearly flat. Apical one-half turn small, globular, glazed and pearly, smooth and concentric. Subsequent whorl much larger, tabulate above and sculptured with three small granulose threads, the upper one very small and situated in front of the suture, the second one situated at the upper shoulder, and the lower one marginates the lower suture; indistinct axials cross the whorl connecting the granules. Following whorls more prominently sculptured, consisting of three on the two subsequent whorls and four (the basal one being doubled) on the last whorl, beaded spiral cords, the anterior third being a little stronger; beads connected axially by retractive threads giving the whorl a cancellate ornamentation and the interspiral space a rhombic pattern. Base of shell with a thin wash of callus but distinctly shows five subequal crenulated spirals lying within a wider, undulated and spirally striated peripheral band. About one-fourth of the last volution is broken away. Columella strong and enameled with a wash of callus.

Dimensions: Type and only specimen (U. S. Nat. Mus. Cat. No. 352689) measures: Altitude 3 mm.; greatest diameter 2.5 mm.

Occurrence.—Middle or lower Miocene: In flood-wash, Caroni County, Montserrat Ward, 1 mile south of Brasso, Trinidad.

Genus LIOTIA Gray

LIOTIA MACHAPOORIEËNSIS, new species

Plate 8, figs. 1, 3

Shell large, solid, perforate, diameter a little greater than altitude, four whorled; whorls rapidly expanding, later ones well rounded; sutural area excavated; suture close-fitting; base nearly flat. Apical whorl flat and broadly coiled. Sculpture of subsequent whorl begins with two weakly nodulous spirals situated at the upper and lower shoulder of the whorl. Soon another median spiral appears. In ascending the whorl, these spirals increase in strength and are adorned with strong, protracted nodules. On the upper half of the body whorl, two other intermediate spirals appear, making five in number. Base with five lowly-nodulous spirals. Aperture subcircular in outline. Outer lip strongly crenulate harmonizing with the exterior sculpture.

Dimensions: Type and only specimen (U. S. Nat. Mus. Cat. No. 352687) measures: Altitude 6 mm.; greatest diameter 6.5 mm.

Occurrence.—Lower Miocene: Nariva County, Charuma Ward, Machapoorie Quarry, Trinidad.

Genus TEINOSTOMA A. Adams

TEINOSTOMA (PSEUDOROTELLA ?) CARONENSIS, new species

Plate 8, figs. 9, 11

Shell small, solid, subhemispherical, three and one-half whorled and consists largely of the last whorl; whorls inflated; suture distinct but shallowly depressed on spire whorls, and closs-fitting and less distinct on body whorl; periphery of body whorl rounded, base slightly rounded. Sculpture on last whorl of close-set, microscopic, spiral striae, being less distinct on the base. Aperture subovate, narrowly and shallowly grooved and pointed at the upper commissure. Umbilical area nearly filled with a heavy wash of callus, transgressing only a little beyond the center of the base. Margin of the inner lip indistinct.

Dimensions: Type and only specimen (U. S. Nat. Mus. Cat. No. 452690) measures: Altitude 1.4 mm.; greatest diameter 2.2 mm.

The new species recalls *Teinostoma vitreum* (Gabb) collected from Santo Domingo, the horizon of which has not been determined, but when compared with Gabb's figured type, the new species has little higher and more domed spire and less constricted whorls and the margin of the inner lip much less distinctly set off.

Occurrence.—Caroni County, Montserrat Ward, Brasso-Gran Couva Road, 100-200 yards west of Brasso, Trinidad. Fossiliferous clay immediately overlying the Turritella-bearing limestone.

Genus ADEORBIS S. Wood

ADEORBIS GUPPYI, new species

Plate 10, figs. 1, 3

Shell fragile, subdiscoidal, spire nearly flat, about four whorled, one-third of last whorl broken off; body whorl with two widely separated spiral carini, the upper one high and thin, and situated near the middle of the whorl forming the periphery, the lower one less prominent and marginates the flat base; area between the carini straight and anteriorly sloping; area in front of the suture depressed. Nucleus smooth; initial turn minute. Subsequent whorl sculptured with three raised primary spiral threads; one is at the upper shoulder, another at the lower shoulder, and the intermediate

one occupies the median part of the whorl; on the following whorl, another spiral begins. Body whorl with seven primary spirals above the peripheral carina and four on the base between the lower carina and the umbilicus. Aside from the primary spirals, there are minute spiral threads—two at first, increasing to four in the depressed subsutural area, many below the carini, and one to two lying between the primary spirals. Umbilicus deep and wide and spirally marked with small threads. A few very fine axials cross the last whorl and enter the umbilicus.

Dimensions: Type and only specimen (U. S. Nat. Mus. Cat. No. 352691) measures: Altitude 1.7 mm.; greatest diameter 4.5 mm.

Occurrence.—Middle or lower Miocene: In flood-wash, Caroni County, Montserrat Ward, 1 mile south of Brasso, Trinidad.

Class SCAPHOPODA

Genus CADULUS Philippi

CADULUS CARONENSIS, new species

Plate 7, fig. 6

The shell is rather small, solid, evenly and quite strongly curved with its greatest diamemter 0.7 mm. from the anterior end where the shell is slightly bulged. The convex arc is quite evenly and broadly rounded posteriorly forward to the equator, the posterior fourth forming a little narrower curve. The convex arc is slightly more curved than the concave side, the posterior region being a little more so. Dorsal slope, at anterior end, is more steeply inclined than on the ventral side. Surface marked by faint, wide-spaced, narrow, low spirals, anteriorly increasing in width. Anterior aperture is broadly elliptical, the lateral axis being the greater; peristome minutely denticulate. Apical aperture nearly round, margins slightly undulated and indistinctly dendiculated.

Dimensions: Type (U. S. Nat. Mus. Cat. No. 352692) measures: Length 5.8 mm.; maximum diameter 1.3 mm.; diameter of anterior aperture, 0.9 mm.; diameter apical aperture, 0.5 mm.

The new species at first inspection recalls *Cadulus parianus* Guppy collected from the "Ditrupa bed," Pointe-à-pierre, Trinidad; but when closely compared is found to be a larger shell, with no marked contraction at its posterior end, and its maximum caliber more anteriorly situated than in Guppy's species. The Eocene species *Cadulus abruptus* Meyer and Aldrich, is quite similar in general aspect to the new speces, but that is a larger shell and has a less curved outline.

Occurrence—Middle or lower Miocene: In flood-wash, Caroni County, Montserrat Ward, 1 mile south of Brasso railway station.

CADULUS PARIANUS Guppy

Cadulus parianus GUPPY, U. S. Nat. Mus. Proc., vol. 19, p. 325, pl. 30, fig. 7, 1896.

Cadulus parianus MAURY, Bull. Amer. Paleont., vol. 10, no. 42, p. 182, 1925.

"Tube round, tapering, suddenly constricted near the broader end. Lon. 3, diam. 0.75 mm." (Guppy 1896).

The figured type well portrays the character of the species. The posterior end is suddenly contracted as shown in the photograph. On all specimens received with the type from Pointe-à-Pierre, the type locality, this feature is present, and is one of the outstanding characters of the species. One specimen belonging to this species was received with the later collection, station 8586, Pointe-à-Pierre.

Genus DENTALIUM Linnaeus

DENTALIUM COSSMANNIANUM Pilsbry and Sharp?

Dentalium dissimile, variety, GABB. Amer. Philos. Soc. Trans., vol. 15, p. 244, 1873.

Dentalium cossmannianum PILSBRY and SHARP, Acad. Nat. Sci. Phila. Proc., vol. 49, p. 467, pl. 10, fig. 11; pl. 11, figs. 10, 11, 1897 (1898).

Dentalium cossmannianum PILSBRY and SHARP, Maury. Bull. Amer. Paleont., vol. 5, p. 323, pl. 52, fig. 3, 1917.

Dentalium cossmannianum PILSBRY and SHARP, Pilsbry, Acad. Nat. Sci. Phila. Proc., p. 399, 1922.

There are a number of fragments, collected at station 8302, one mile south of Brasso, that appear to belong to this species. One larger fragment is marked with very faint interaxial longitudinal threads, a feature not shown on the Dominican species, otherwise it agrees with that species.

The Dominican species was collected from the Gurabo formation during the U. S. Geological Survey reconnaissance to that island in 1919.

Dentalium bocasensis Olsson, referred to the Gatun stage and collected from Bocas del Toro, Panama, possesses intermediate longitudinal ribs aside from the six primary ones. The indeterminate species may be closer to that species.

DENTALIUM, species

There are several fragments of *Dentalium* at station 8301, Machapoorie Quarry, representing mainly only the early part of the shell. In general, they recall *Dentalium gabbi* Pilsbry and Sharp, and may prove when better specimens are obtained to be closely related to that species. The very earliest part is hexagonal in outline. The upper extremity is well rounded and reveals indistinct axials, perhaps being obliterated by corrosion. Their relationship to the forms at station 8302 apparently is very close.

DENTALIUM, species (2 species?)

Figs. 1, 9. *Conus multiliratus walli*, new subspecies. Fig. 9, type; alt. 21 mm.;

There are a number of fragments of the genus *Dentalium* from station 8302, one mile south of Brasso, that may represent one or two new species. They all belong to the group having an early hexagonal shell. They indicate a rather slender and nearly straight shell, the posterior extremity being more curved than the later part. Irregular, spiral swellings give the shell an undulated appearance. An interaxial appears early on the shell between the six primary ones; soon other interaxials come in rounding out the surface in ascending.

The forms are apparently related to *Dentalium gabbi* Pilsbry and Sharp from Santo Domingo. A very similar form occurs at station 6033–*c*, Canal Zone, a horizon assigned to the Gatun formation.

EXPLANATION OF PLATES

Plate 1

Figs. 1, 4. *Conus trinitatensis*, new species; type; alt. 20 mm.; page 12.

2. *Drillia pennyi acaria*, new subspecies; type; alt. 5.2 mm.; page 18.

3, 6. *Conus springvaleënsis*, new species; type; alt. 27.0 mm.; page 11.

5. *Terebra* (*Strioterebra*) *brassoënsis*, new speceies; type; alt. 6.2; page 10.

7, 9. *Cylichnella ovum-lacerti* (Guppy): figured cotype; alt. 3.3 mm.; page 9.

8. *Terebra* (*Strioterebra*) *trinitatensis*, new species; type; alt. 9 mm.; page 10.

Plate 2

Figs. 1, 9. *Conus multilratus walli*, new subspecies. Fig. 9, type; alt. 21 mm.; Fig. 1, specimen from same station as type; alt. 16 mm.; page 13.

2. *Turricula springvaleënsis*, new species; type; alt. 44 mm.; page 13.

3, 4. *Drillia propefusiformis*, new species. Fig. 3, type; alt. 34 mm.; fig. 4, specimen from same station as type; alt. 13 mm.; page 20.

5, 10. *Conus manzanillaënsis*, new species; type; alt. 40 mm.; page 12.

6. *Drillia manzanillaënsis*, new species; type; alt. 13 mm. page 23.

7, 8. *Turris brassoënsis*, new species; cotype. Fig. 8, alt. 16 mm.; page 14.

11. *Typhis sawkinsi*, new species; type; alt. 15 mm.; page 48.

12. *Cancellaria springvaleënsis*, new species; type; alt. 21 mm.; page 31.

Plate 3

Figs. 1, 5. *Drillia daditrina*, new species. Fig. 1, type; alt. 8.4 mm.; fig. 5, specimen from same station as type; alt. 10 mm.; page 19.

2. *Drillia pennyi*, new species; type; alt. 9.3 mm.; page 17.

3. *Drillia nitrina*, new species; type; alt. 6.5 mm.; page 22.

4, 9. *Drillia inniadda*, new species; cotypes. Fig. 4. alt. 9 mm.; fig. 9, alt. 6 mm.; page 21.

6. *Drillia inadrina*, new species; type; alt. 6.6 mm.; page 22.

7. *Mangilia micropleura* Guppy. Figured specimen of largest cotype; alt. 6 mm.; page 25.

8. *Drillia*, species aff. *D. rioguraboni*s Maury; alt. 10 mm. Station 9224, Springvale near Couva; page 24.
10. *Drillia consors bullbrooki*, new subspecies; type; alt. 18 mm.; page 16.
11. *Drillia tridadina*, new species; type; alt. 7.5 mm.; page 19.
12, 13. *Drillia consors trinitatensis*, new subspecies; cotypes. Fig. 12, alt. 6.5 mm.; fig. 13, alt. 13 mm.; page 17.

PLATE 4

FIG. 1. *Glyphostoma caronensis*, new species; type; alt. 8.6 mm.; page 26.
2, 3. *Glyphostoma amicta rintriada*, new subspecies. Fig. 2, alt. 3.2 mm.: fig. 3, alt. 4.3 mm.; page 27.
4. *Glyphostoma? triniada*, new species; type; alt. 5.2 mm.; page 26.
5. *Microdrillia trina*, new species; type; alt. 6 mm.; page 28.
6, 8. *Drillia niaddrina*, new species; cotypes. Fig 6, alt. 11 mm.; fig. 8, alt. 7.6 mm.; page 23.
7. *Microdrillia propetrina*, new species; type; alt. 3.6 mm.; page 29.
9. *Glyphostoma? addrina*, new species; type; alt. 6.2 mm.; page 28.
10. *Drillia ritanida*, new species; type; alt. 8.5 mm.; page 24.

PLATE 5

FIG. 1. *Marginella (Faba) bullbrooki*, new species; type; alt. 4.3 mm.; page 36.
2, 7. *Ancilla paralamellata*, new species; cotypes. Fig. 2, alt. 10 mm.; fig. 7, alt. 27.5 mm.; page 33.
3. *Cancellaria bullbrooki*, new species; type; alt. 7.3 mm.; page 31.
4. *Ancilla caroniana* Maury; figured specimen; alt. 41 mm.; page 34.
5. *Ancilla caroniana springvaleënsis*, new subspecies; alt. 35 mm.; page 35.
6. *Pseudoliva guppyi*, new species; type; alt. 10.5 mm.; page 32.
8. *Borsonia (Paraborsonia) brassoënsis*, new species; type; alt. 14.3 mm.; page 30.

PLATE 6

FIGS. 1, 2, 3. *Marginella guppyana*, new species. Figs. 1, 3 type; alt. 18 mm.; fig. 2, apical view of another specimen from type locality; alt. 9 mm.; page 37.
4. *Marginella (Faba) brassoënsis*, new species; type; alt. 3.5 mm.; page 36.
5, 6. *Marginella solitaria montserratensis*, new subspecies; type; alt. 2.7 mm.; page 39.
FIG. 7. *Marginella (Closia) nitrina*, new species; type; alt. 2 mm.; page 40.
8. *Marginella (Gibberula) trinitatensis*, new species; type; alt. 4 mm.; page 41.
9. *Marginella (Closia) lachrimula* Gould? Alt. 3 mm.; page 40.
10. *Marginella (Persicula) propeobesa*, new species; type; alt. 10 mm.; page 41.
11. *Marginella calypsonis* Maury; figured specimen; alt. 20 mm.; page 39.
12. *Marginella guaica* Maury; figured specimen; alt. 13.6 mm.; page 38.
13. *Marginella springvalensis* Maury; figured specimen; alt. 36 mm.; page 38.

PLATE 7

FIGS. 1, 2. *Modulus tamanensis* Maury; Fig. 2, figured specimen, alt. 29 mm.; fig. 1, specimen from station 8301, Machapoorie Quarry, showing better preserved nucleus, alt. 10.0 mm.; page 49.

3. *Alectrion brassoënsis*, new species; type: alt. 5.2 mm.; page 46.

4. *Phos bullbrooki*, new species; type; alt. 13.4 mm.; page 45.

5. *Phos trinitatensis*, new species; type; alt. 22 mm.; page 44.

6. *Cadulus caronensis*, new species; type; length, 5.8 mm.; page 61.

7, 8. *Metulella caronensis*, new species (? "*Strombina*" *costaricensis* Olsson, new subspecies); cotypes; Fig. 7, early whorls of specimen A, enlarged about six times; fig. 8, specimen B, alt. 14.5, page 46.

9, 11. *Mitra longa* var. *couvensis* Maury; figured specimen; alt. 55 mm.; page 42.

10. *Turritella machapoorensis* Maury; figured specimen; alt. 29 mm.; page 52.

PLATE 8

FIGS. 1, 3. *Liotia machapooriënsis*, new species; type; alt. 6 mm.; page 59.

2. *Vexillum bristoli* (Maury), figured specimen; alt. 7.5 mm.; page 43.

4, 8. *Calliostoma rhombotum*, new species; type; alt. 3 mm.; page 59.

5, 7. *Strombina walli*, new species; type; alt. 6.0 mm.; page 47.

6. *Caecum properegulare*, new species; type; length 1.5 mm.; page 50.

9, 11. *Teinostoma* (*Pseudorotella?*) *caronensis*, new species; type; alt. 1.4 mm.; page 60.

10. *Cypraea trinitatensis*, new species; type; length 39 mm.; page 49.

12, 13, 14. *Turritella gatunensis caronensis*, new subspecies; cotypes. Fig. 12 (×5); fig. 13 (×4); fig. 14 (×8); page 51.

PLATE 9

FIGS. 1, 9. *Turritella planigyrata* Guppy. Fig. 1, cotype; alt. 41 mm.; U. S. Nat. Mus. Cat. No. 115626; fig. 9, basal whorls of a specimen from station 9195, Springvale, near Couva; diameter 23 mm.; page 55.

2, 3, 4. *Petaloconchus alcimus*, new species; cotypes. Fig. 2, early spiral coils; fig. 3, later spirals; fig. 4, shows two internal laminae, page 51.

5, 6. *Turritella montserratensis*, new species; cotypes. Length of specimen (fig. 5), 10 mm.; fig. 6, 39 mm.; page 53.

7, 8. *Turritella* aff. *T. perattenuata praecellens* Pilsbry and Brown; page 55.

10, 11. *Turritella caparonis* Maury; figured specimens; page 53.

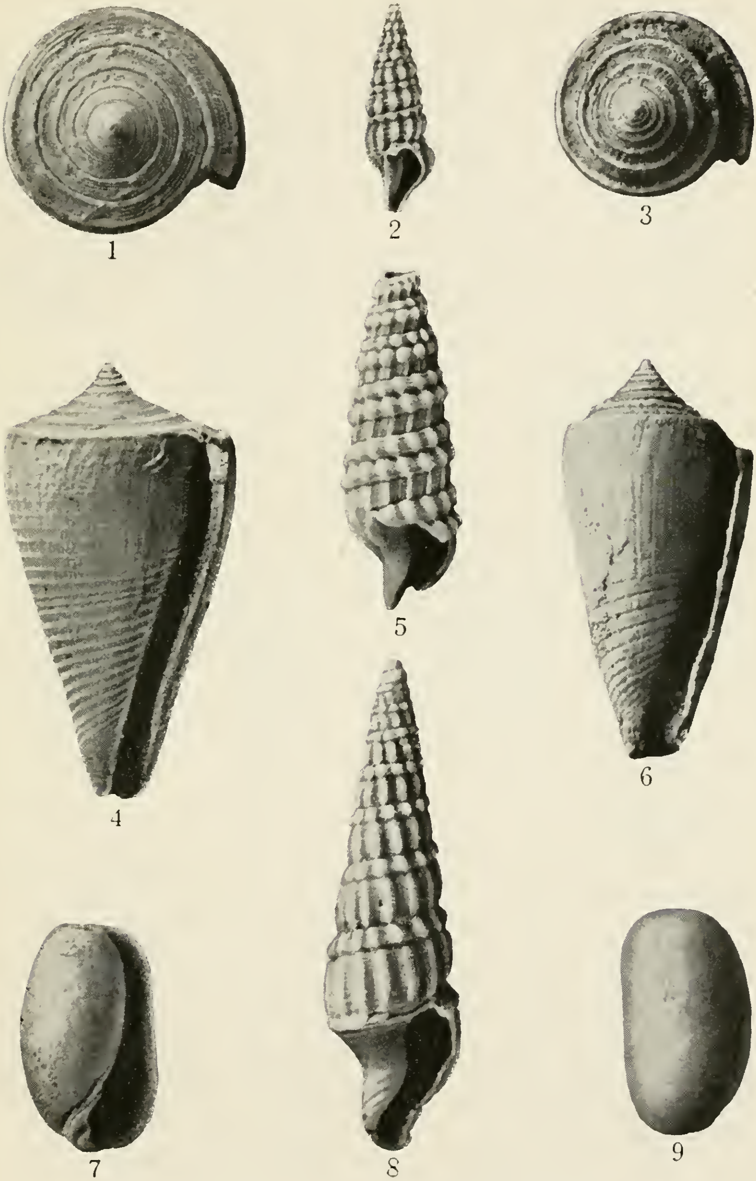
PLATE 10

FIGS. 1, 3. *Adeorbis guppyi*, new species; type; greatest diameter, 4.5 mm.; page 60.

2, 5. *Turritella*, species cf. *T. altilira*, var. *chiriquiensis* Olsson (×3), page 54.

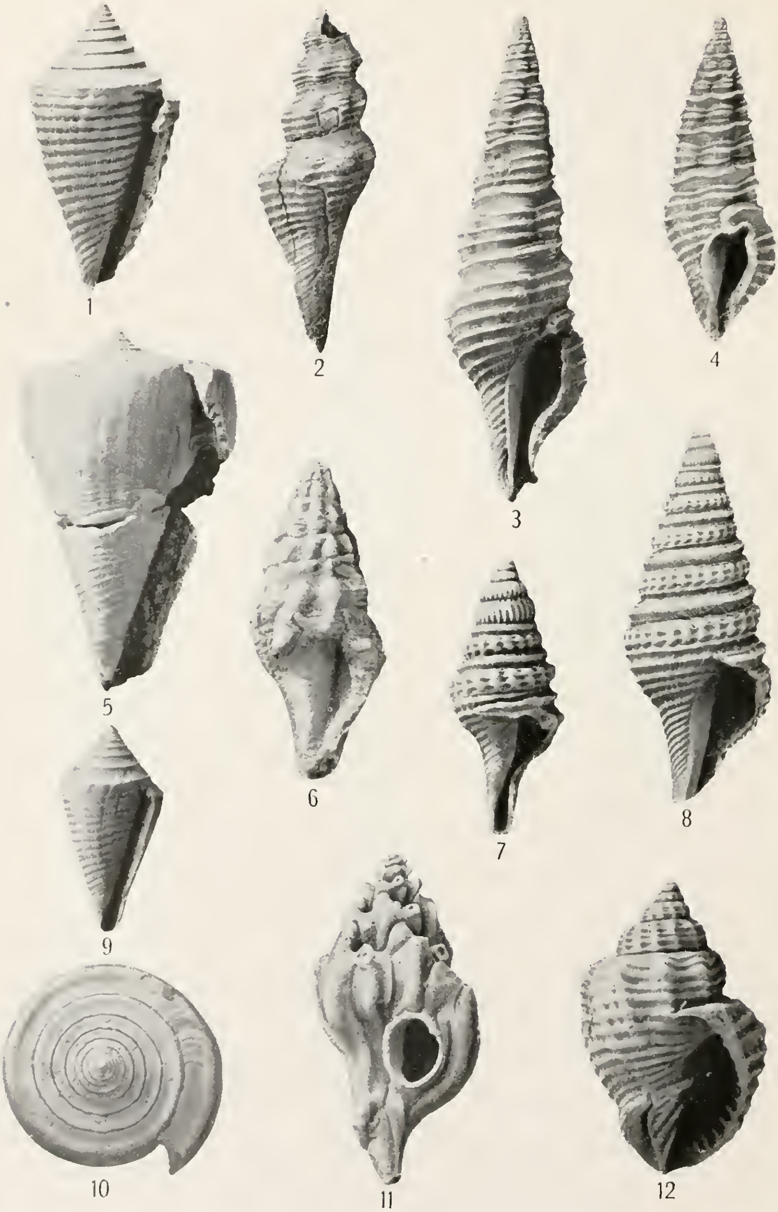
4, 6. *Amauropsis trinitatensis*, new species; type; alt. 45 mm., page 58.

7, 8. *Calliostoma attrina*, new species; type; alt. 13 mm.; page 58.



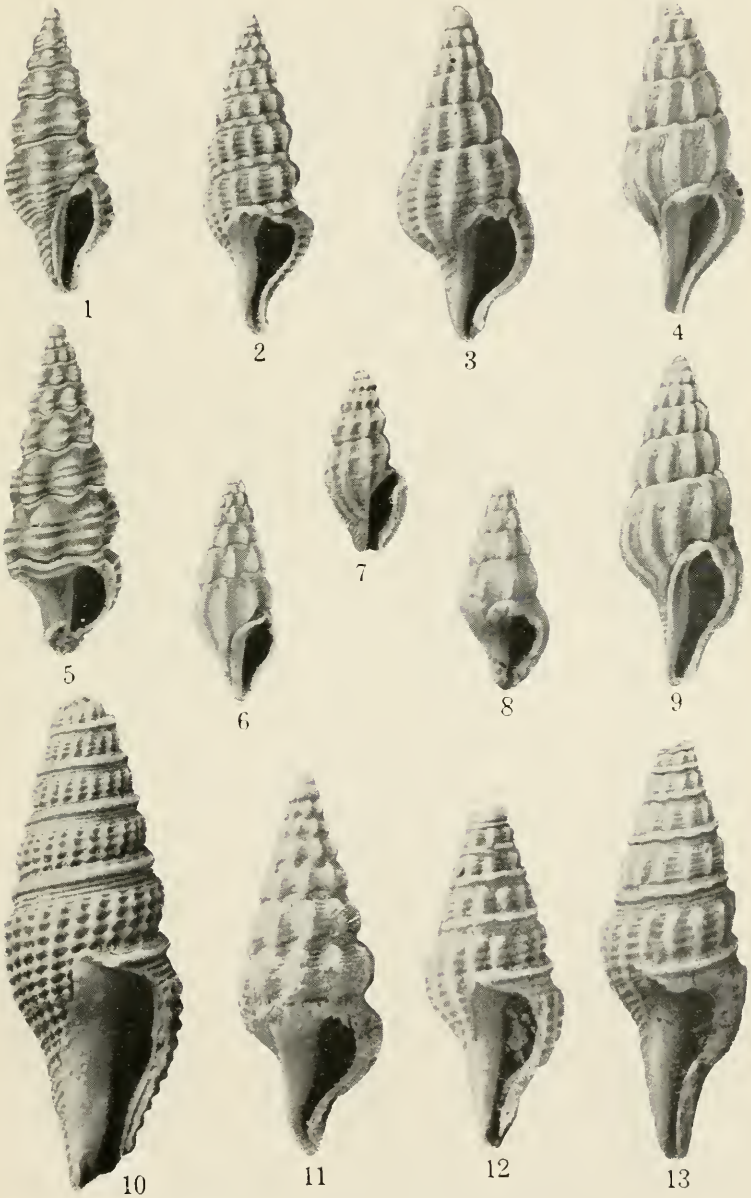
MIOCENE GASTROPODS FROM TRINIDAD

FOR EXPLANATION OF PLATE SEE PAGE 63



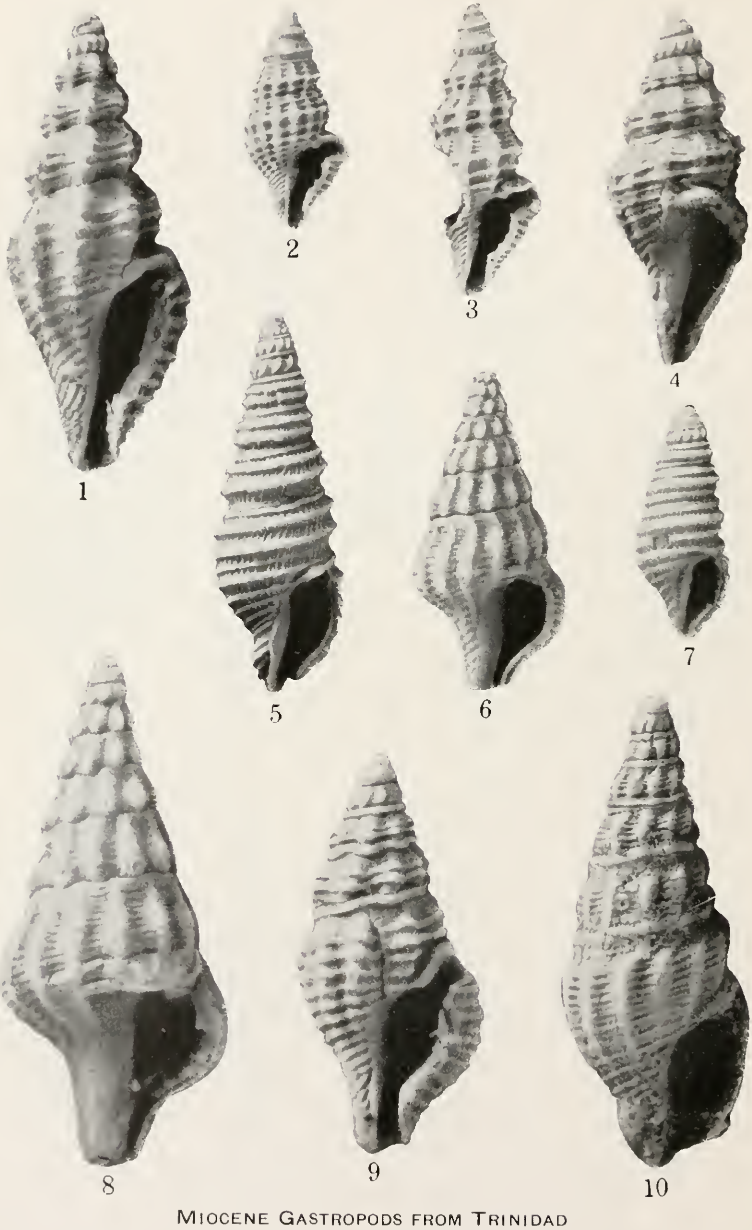
MIOCENE GASTROPODS FROM TRINIDAD

FOR EXPLANATION OF PLATE SEE PAGE 63



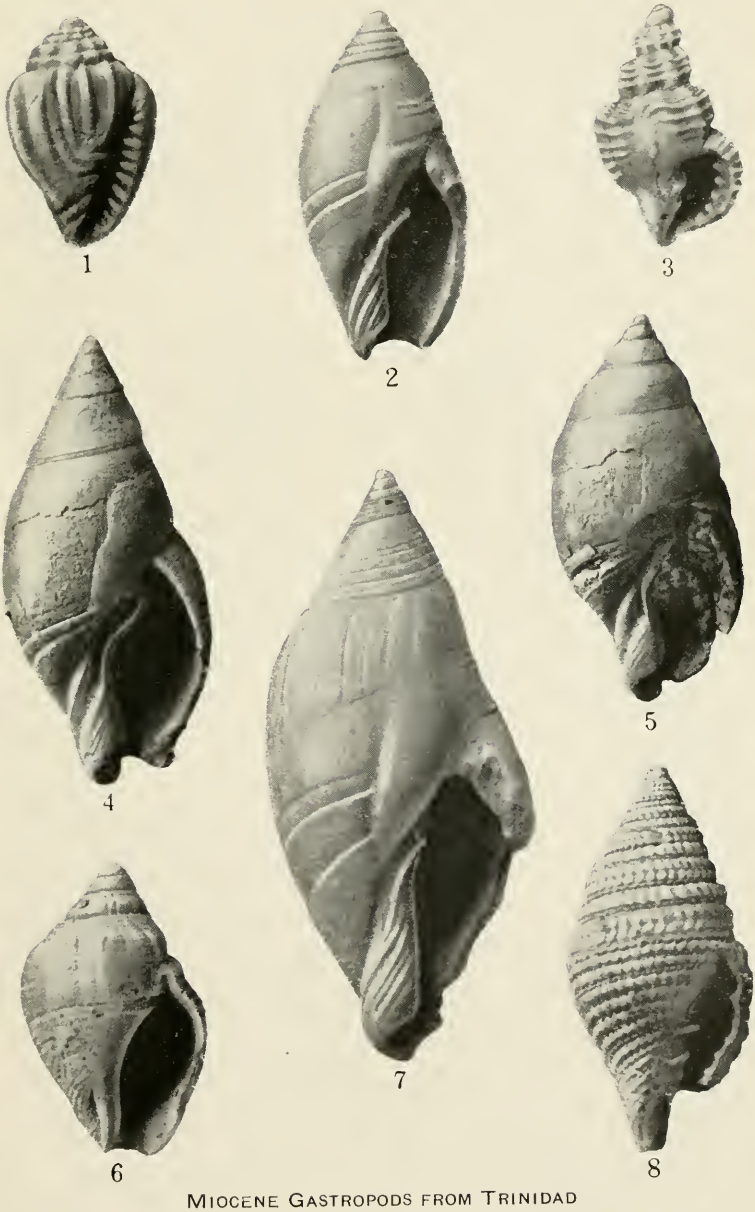
Miocene Gastropods from Trinidad

For explanation of plate see pages 63 and 64



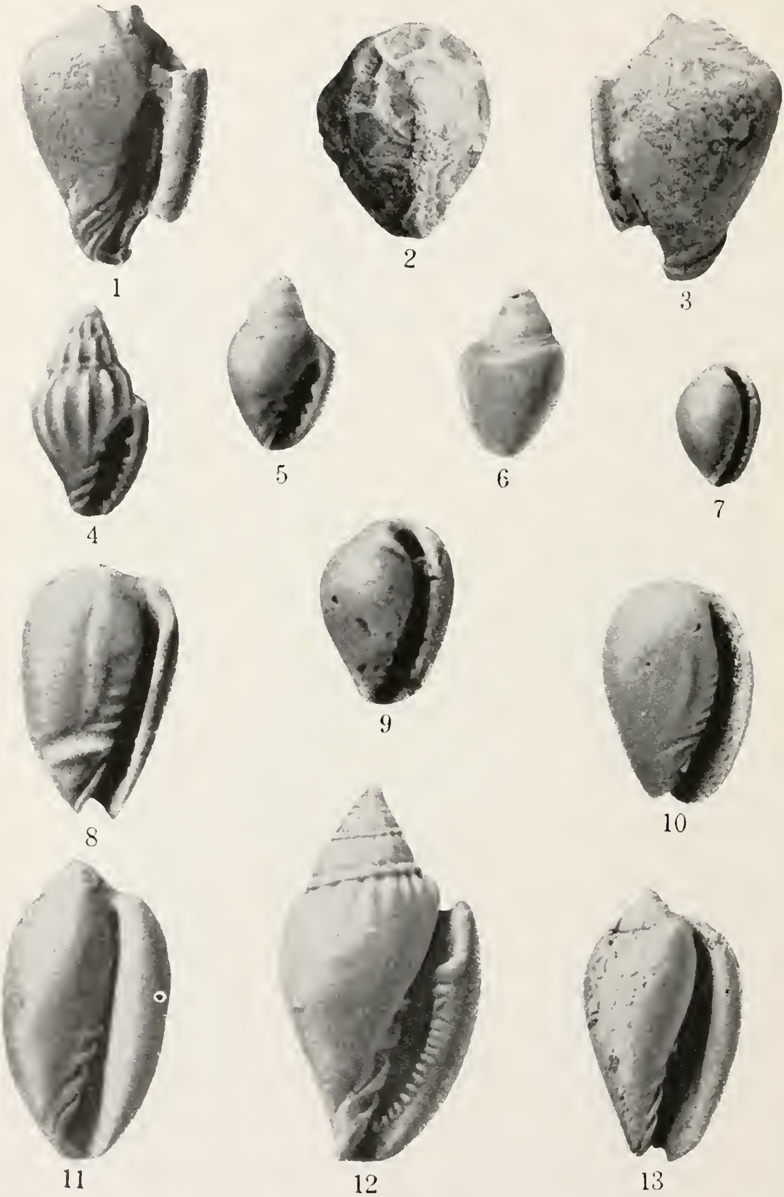
MIOCENE GASTROPODS FROM TRINIDAD

FOR EXPLANATION OF PLATE SEE PAGE 64



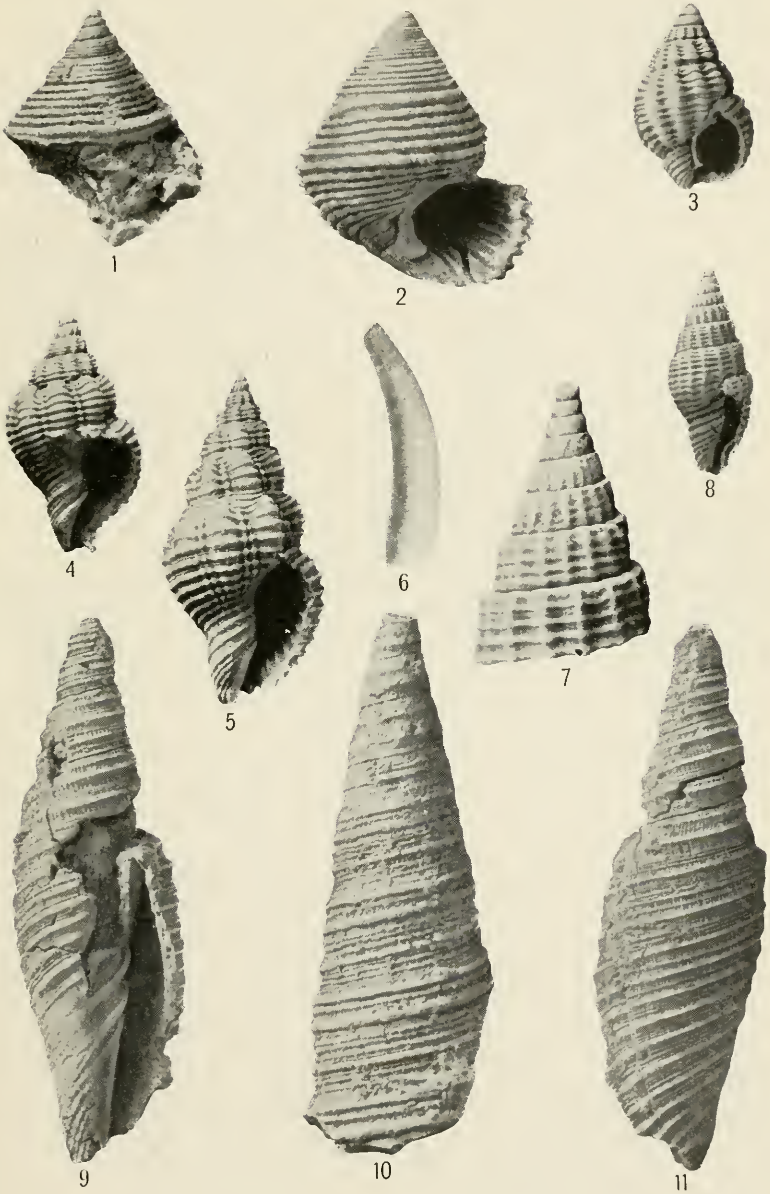
MIOCENE GASTROPODS FROM TRINIDAD

FOR EXPLANATION OF PLATE SEE PAGE 64



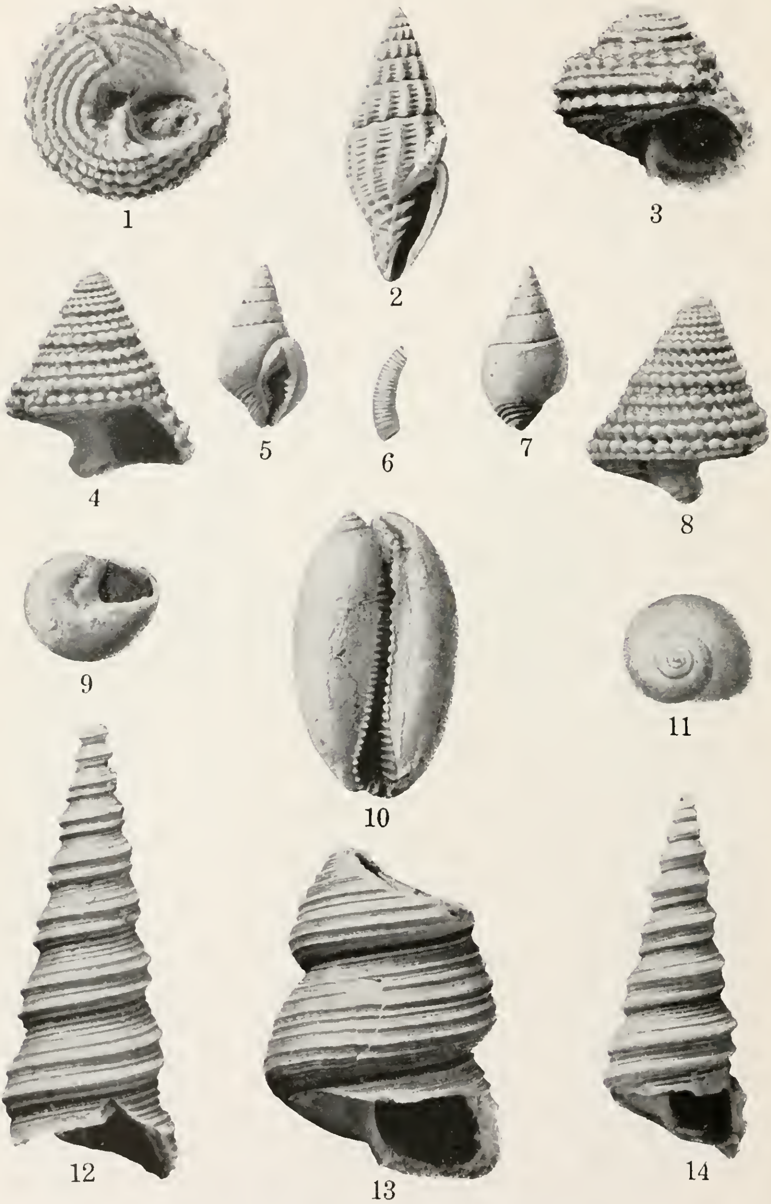
MIOCENE GASTROPODS FROM TRINIDAD

FOR EXPLANATION OF PLATE SEE PAGE 61



MIOCENE GASTROPODS AND SCAPHOPODS FROM TRINIDAD

FOR EXPLANATION OF PLATE SEE PAGE 65



MIOCENE GASTROPODS FROM TRINIDAD

FOR EXPLANATION OF PLATE SEE PAGE 65

MIOCENE GASTROPODS FROM TRINIDAD

FOR EXPLANATION OF PLATE SEE PAGE 65

MIOCENE GASTROPODS FROM TRINIDAD

FOR EXPLANATION OF PLATE SEE PAGE 65

A REVISION OF THE NORTH AMERICAN SPECIES OF THE GENUS ARGYRA MACQUART, TWO-WINGED FLIES OF THE FAMILY DOLICHOPODIDAE

By M. C. Van Duzee

Of Buffalo, New York

The present paper is a review of the North American species of the genus *Argyra* and contains descriptions of 26 new species as well as a more or less complete redescriptions of the species previously described.

The association of the females with the males is in some cases subject to doubt; but with the large amount of material in my hands I have felt little uncertainty in placing them.

Measurements of the tarsal joints are given for all the species; these were made with an eyepiece micrometer, and each unit is very nearly one-fiftieth of a millimeter.

I am greatly indebted to Dr. J. M. Aldrich for the loan of his material (since donated to the National Museum): to C. W. Johnson, who sent me his material and that of the Boston Society of Natural History, and started me at work on the genus; also to C. H. Curran, of the Entomological Branch, Ottawa, Canada, who sent me three very interesting forms, new to me.

Genus ARGYRA Macquart

Argyra Macquart, Hist. Nat. Dipt., vol. 1, 1834, p. 456.—Loew, Smiths. Misc. Colls., No. 171, 1864, pp. 123–132.—Becker, Nova Acta, vol. 104, pt. 2, 1918, pp. 61–74.

Leucostola Loew, Neue Beiträge, vol. 5, p. 39, 1857; vol. 8, p. 63, 1861; Smiths. Misc. Colls., No. 171, p. 151.—Becker, Nova Acta, vol. 104, pt. 2, p. 74, as subgenus.

Macquart included seven species in 1834, of which Rondani designated *Musca diaphana* Fabricius as type.[1] The type of *Leucostola* is *Dolichopus vestitus* Wiedemann, the only species originally included.

Since the publication of Loew's Monograph in 1864 only three species have been described—*aldrichi* and *robusta* by Johnson, and *ciliata* by me.

[1] Prod. Dipt. Ital., vol. 1, 1856, p. 141.

Following Becker[2] I recognize two subgenera, *Argyra* and *Leucostola.* The former has the first antennal joint hairy above, while it is bare in the latter. The character dwindles in value, until in several species there is only one hair on the joint. All our species of *Leucostola* have the thorax polished green with more or less silvery white pollen, as in typical *Argyras;* the abdomen in all has considerable yellow on the basal segments; the antennae, venation, and hypopygial structures are alike in both groups.

KEYS TO THE NORTH AMERICAN SPECIES OF THE GENUS ARGYRA

A. Subgenus Argyra—Males

1. Abdomen without yellow on the sides, or very nearly so ---------- 2
   Abdomen with distinct yellow ground color on some of the segments --- 13
2. Anterior coxae wholly black, or nearly so ---------- 3
   Anterior coxae yellow, at least on apical half ---------- 10
3. Hind basitarsus with long bristles ---------- 4
   Hind basitarsus with only the usual short hairs ---------- 5
4. All femora black with their tips narrowly yellow (Washington), 8, **nigriventris**, new species.
   All femora yellow, except apical half of posterior pair (California), 9, **argentiventris**, new species.
5. Middle femora widened below near basal third, so as to form an obtuse angle; their tibiae with a brush of hairs near the middle (California), 10, **femoralis**, new species.
   Middle femora nearly evenly rounded or straight below ---------- 6
6. All femora yellow, their base may be slightly blackened (Oregon), 7, **scutellaris**, new species.
   Fore and middle femora black; posterior pair yellow with apical third black (New England) ---------- 31, **obscura**, new species.
   All femora black, their tips may be yellow ---------- 7
7. Face and front velvety black (Alaska; California; Washington; Idaho), 1, **nigripes** Loew.
   Face white or grayish white; front metallic green with more or less gray pollen ---------- 8
8. Anterior tibiae with long hair on their posterior surface and the usual bristles above (California) ---------- 6, **barbipes**, new species.
   Anterior tibiae without long hair ---------- 9
9. Hind tibiae wholly black; scutellum bare on the disk (Colorado), 2, **hirta**, new species.
   Hind tibiae partly yellow; scutellum with numerous hairs on the disk (Canada) ---------- 14, **bimaculata**, new species.
10. Hind femora not at all infuscated at tip; fore coxae with only pale hairs and bristles (Wisconsin; Maine; New York) -- 4, **angustata**, new species.
    Tips of hind femora and the bristles of the fore coxae black ---------- 11
11. Hind basitarsus with long bristles (California), 9, **argentiventris**, new species.
    Hind basitarsus with only the usual short hair ---------- 12
12. Arista three or four times as long as the third antennal joint; black hair and bristles of fore coxae conspicuous (California) -- 3, **cylindrica** Loew.
    Arista not as long as third antennal joint; fore coxae nearly bare, except the bristles at tip (Louisiana) ---------- 5, **brevipes**, new species.

[2] Nova Acta, vol. 104, pt. 2, p. 74.

13. One pair of femora more than half black or green---------------------- 14
All femora yellow, tips of posterior pair may be broadly black---------- 19
14. All femora black or green, their tips may be yellow--------------------- 15
One or two pairs of femora largely yellow----------------------------- 18
15. Face velvety black-------------------------------- 15, **velutina**, new species.
Face silvery white -- 16
16. Cilia of the calypters black (Alaska; Oregon; Washington; Idaho), 11, **albiventris** Loew.
Cilia of the calypters pale yellow------------------------------------- 17
17. Second and third abdominal segments largely yellow (New England; New Jersey; Montana; Idaho; Canada)---------------- 12, **robusta** Johnson.
Abdomen with very indistinct yellow spots on second segment (Canada), 14, **bimaculata**, new species.
18. Fore femora black on upper and most of posterior surface; middle ones yellowish; hind pair blackened on apical half above (California), 16, **splendida**, new species.
Fore and middle femora black with yellow tips; hind ones with apical third black (New England)------------------------ 31, **obscura**, new species.
Fore femora black on basal half; middle ones on basal half of posterior surface; hind femora black on more than apical third (Alaska), 13, **ciliata** Van Duzee.
19. Tips of hind femora black, at least distinctly infuscated-------------- 20
Hind femora not, or scarcely darkened at tip------------------------- 31
20. Fore coxae almost wholly black------------------------------------- 21
Fore coxae yellow, sometimes considerably blackened at base---------- 22
21. Middle femora with a row of long black hairs on both anterior and posterior edges of lower surface (California)--- 21, **californica**, new species.
Middle femora with one row of black bristles on the anterior edge of lower surface, none on posterior edge (Ohio)------- 20, **nigricoxa**, new species.
22. Second joint of hind tarsi not very much shorter than first, which has only the usual short hair-- 23
Second joint of hind tarsi not, or scarcely half as long, as the first, which is furnished with long bristles------------------------------------ 29
23. Fore and middle femora with conspicuously longer yellow hairs below (Middle and Eastern States; Canada)--------------- 23, **calceata** Loew.
Fore femora and sometimes the middle ones also, with long black hairs or bristles below, if they have yellow hairs below, then the hairs are scarcely longer than those on upper surface------------------------ 24
24. Hind tarsi wholly yellow--- 25
Hind tarsi wholly black-- 26
25. Posterior surface of fore femora with long black hair; posterior edge of pleurae black as usual (District of Columbia; New Jersey; New York; Pennsylvania; Massachusetts)----------------------- 28, **minuta** Loew.
Fore femora with only short black hair; posterior edge of pleurae yellow (Maryland; Indiana)------------------------- 29, **flavipes**, new species.
26. Hind tibiae wholly black, still sometimes yellowish brown at base (New York; Canada)----------------------------- 18, **thoracica**, new species.
Hind tibiae yellow with a black tip----------------------------------- 27
27. Scutellum with a few small black hairs on its disk; hind femora broadly black at tip (Virginia to Canada)------------------ 17, **albicans** Loew.
Hind femora wholly yellow or very narrowly black or brown at tip; scutellum bare on its disk--- 28

28. Fore coxae distinctly blackened at base and with conspicuous black hairs (Maine; Massachusetts; Canada) ---------- 22, **sericata**, new species.
    Fore coxae wholly yellow, almost bare except for the bristles near the tip (Quebec) ---------- 24, **albicoxa**, new species.
29. Hind basitarsus wholly black (California) -- 9, **argentiventris**, new species.
    Hind basitarsus mostly yellow ---------- 30
30. Hind tarsus with its joints as 32–13–13–10–9, first joint much thickened and with numerous bristles (Virginia to Canada ---------- 25, **calcitrans** Loew.
    Joints of hind tarsi as 50–20–18–11–8, their first joint scarcely thickened and with a few bristles on each edge, of lower surface (Vermont; New York; New Jersey; Ontario) ---------- 26, **setipes**, new species.
31. Antennae yellow, third joint very narrowly black on upper edge (Kansas; Louisiana) ---------- 30, **flavicornis**, new species.
    Antennae black or brown ---------- 32
32. Hind basitarsi with numerous bristles (Virginia to Canada), 25, **calcitrans** Loew.
    Hind basitarsi with only the usual short hair ---------- 33
33. Hind basitarsi wholly black or nearly so ---------- 34
    Hind tarsi wholly yellow, or slightly darkened at tip ---------- 39
34. Hypopygium large, contracted in the middle (fig. 19), its lamellae long and curved (New Jersey; Connecticut; Rhode Island) -- 27, **aldrichi** Johnson.
    Hypopygium not large or contracted, normal ---------- 35
35. Posterior edge of pleurae and first abdominal segment yellow ---------- 36
    Posterior edge of pleurae and first abdominal segment blackish ---------- 37
36. Second and third abdominal segments with a longitudinal black or green stripe (Middle and Eastern States; Canada) ---------- 23, **calceata** Loew.
    Second and third abdominal segments wholly yellow, except the narrow hind margins (New York; Canada) ---------- 24, **albicoxa**, new species.
37. Fore coxae wholly pale yellow with silvery pollen; middle femora with only short hairs below (Ontario; Quebec) ---------- 19, **currani**, new species.
    Fore coxae blackened at base, or wholly black; middle femora with long black or brown bristles below ---------- 38
38. Fore coxae wholly black (Ohio) ---------- 20, **nigricoxa**, new species.
    Fore coxae yellow, blackened at base (Maine; Massachusetts; Canada), 22, **sericata**, new species.
39. Arista inserted before apical third of third antennal joint (Maryland; Indiana) ---------- 29, **flavipes**, new species.
    Arista inserted close to the tip of third antennal joint as usual (Eastern States) ---------- 28, **minuta** Loew.

Females

1. Abdomen without yellow on the dorsum, at most with indistinct lateral spots on second segment ---------- 2
   Abdomen with distinct yellow ground color on some of the segments --- 15
2. Scutellum with hairs on its disk ---------- 3
   Scutellum bare, except the marginal bristles ---------- 6
3. All femora wholly yellow, except sometimes at tip ---------- 4
   Fore and middle femora more or less blackened at base ---------- 5
4. Hind femora wholly yellow ---------- 7, **scutellaris**, new species.
   Hind femora broadly black at tip ---------- 14, **bimaculata**, new species.
5. Cilia of the calypters yellowish ---------- 12, **robusta** Johnson.
   Cilia of the calypters black ---------- 15, **velutina**, new species.
6. Fore and middle femora black on basal half or more- 13, **ciliata** Van Duzee.
   All femora yellow, the tips of posterior pair may be black ---------- 7

7. Hind femora without black at tip, at most the tip is only slightly brownish above ---------- 8
Hind femora distinctly blackened at tip, at least above---------- 12
8. Hind tarsi almost wholly yellow; first joint distinctly longer than second ---------- 9
Hind tarsi partly or wholly black, first and second joints of nearly equal length---------- 10
9. Second joint of hind tarsi about two-thirds as long as first.
25, **calcitrans** Loew.
Second joint of hind tarsi less than half as long as first.
4, **angustata**, new species.
10. First joint of hind tarsus blackish at tip only, second usually yellowish at base---------- 21, **californica**, new species.
Hind tarsus almost wholly black---------- 11
11. The portion of the face below the suture nearly as long as wide.
3, **cylindrica** Loew.
Portion of face below the suture about half as long as wide.
14, **bimaculata**, new species.
12. First joint of hind tarsus nearly twice as long as second.
8, **nigriventris**, new species.
First and second joints of hind tarsus of nearly equal length---------- 13
13. Abdomen bright shining green, almost without pollen.
6, **barbipes**, new species.
Abdomen dulled with grayish pollen, at least on the sides---------- 14
14. Apical third or more of hind tibiae black---------- 1, **nigripes** Loew.
Not over apical fourth of hind tibiae infuscated, and only brown, not black.
10, **femoralis**, new species.
15. Scutellum with hairs on its disk---------- 16
Scutellum bare, except for the usual marginal bristles---------- 17
16. Thorax with a little snow-white pollen; scutellum with only a few hairs on its disk; yellow spots on second abdominal segment distinct.
17, **albicans** Loew.
Thorax with thick brownish pollen; disk of scutellum with many conspicuous hairs; yellow spots on the second abdominal segment very indistinct.
12, **robusta** Johnson.
17. Antennae yellow, third joint very narrowly black above.
30, **flavicornis**, new species.
Antennae wholly black or brown---------- 18
18. Hind tarsi wholly black, or very nearly so---------- 19
Hind tarsi wholly yellow, or only slightly darker at tip---------- 23
First joint of hind tarsus yellow with a black tip---------- 25
19. Second joint of hind tarsus considerably longer than the first.
27, **aldrichi** Johnson.
First and second joints of hind tarsi of nearly equal length---------- 20
20. Hind margin of the pleurae yellow---------- 23, **calceata** Loew.
Hind margin of the pleurae blackish---------- 21
21. Second and third abdominal segments yellow with their hind margins black.
18, **thoracica**, new species.
Yellow of the abdomen confined to a rather small spot on each side of the second segment; sometimes there are indistinct spots on the sides of the third segment also ---------- 22
22. Tip of hind tibiae narrowly blackened---------- 19, **currani**, new species.
Hind tibiae black at tip for one-fourth their length.
22, **sericata**, new species.

23. Fourth, fifth, and most of third abdominal segments black or green. 28, **minuta** Loew.
Abdomen yellow with the last segment and narrow hind margins of the others black or green ---------- 24
24. Palpi black or brown ---------- 29, **flavipes**, new species.
Palpi yellow ---------- 26, **setipes**, new species.
25. Abdomen black with yellow spots on the sides of second, third, and sometimes the fourth segments ---------- 11, **albiventris** Loew.
Abdomen yellow with the last segment and narrow hind margins of the others black or green ---------- 26, **setipes**, new species.

B. Subgenus Leucostola—Males

1. Hind femora black or brown at tip, at least above ---------- 2
Hind femora wholly yellow ---------- 4
2. Hind tibiae and tarsi almost wholly blackish ---------- 34, **involuta**, new species.
Hind tibiae wholly yellow ---------- 3
3. Hind tarsus with its joints in the proportion of 23–17–12–8–6 (Indiana). 36, **inaequalis**, new species.
Hind tarsus with its joints as 24–23–16–9–7 (Indiana). 37, **spina**, new species.
4. Hairs of fore coxae yellow, their bristles black (Florida). 35, **flavicoxa**, new species.
Hairs and bristles of fore coxae wholly yellow ---------- 5
5. Tip of hind basitarsus slightly enlarged and with close-set little hairs which make it appear even larger (District of Columbia; Virginia; New York; New Jersey; Indiana; Louisiana) ---------- 32, **cingulata** Loew.
Hind basitarsus not at all enlarged at tip, but with a row of equally spaced, stiff, little hairs below, which are continued on the following joints (New Jersey; Pennsylvania) ---------- 33, **johnsoni**, new species.

1. ARGYRA NIGRIPES Loew

Argyra nigripes Loew, Smiths. Misc. Coll., No. 171, p. 127, 1864.

Male.—Length, 3.5–4.5 mm. Front and face velvety black, the latter moderately narrow. Proboscis and palpi black, with black hairs. Antennae black; first joint with conspicuous hairs above; third joint about as long as the first, rounded at tip; arista inserted before the tip, as long as the antenna. Lower orbital cilia vary in color from brownish gray to grayish white; the minute black upper orbital cilia reach to about the middle of the eye height.

Dorsum of thorax shining green with coppery reflections, its silvery pollen confined to the sides; sometimes the scutellum and posterior part of the thorax are a beautiful blue color; scutellum with two pair of marginal bristles, the outer about half as long as the median pair; pleurae black, with white pollen. Abdomen black, with two first segments more or less green, thickly covered with silvery white pollen; its hairs and bristles rather long, wholly black. Hypopygium (fig. 1) and its appendages black, penis yellow; the outer lamellae are broad, obtusely pointed at tip, fringed with long black hairs.

Coxae black, anterior and posterior pairs sometimes yellowish on apical half; fore and middle pairs with long black bristlelike hairs; hind ones with two bristles on outer surface. All femora black, sometimes a little yellow at base. Fore femora and tibiae with long, slender, black hairs on posterior surface, which are longer than the width of the femora; middle femora with a row of stout hairs on lower anterior edge of apical two-thirds, not as long as the width of the femora and shorter toward the tip; hind femora with a row of hairs on lower outer edge which are about as long as the upper row on outer edge. All tibiae yellow, the posterior ones black at tip for one-fifth their length, still the black is not sharply defined and sometimes reaches the middle of the tibiae; middle tibiae rather stout, with long bristles above and a few long hairs below, the longest being near apical third and about as long as the thickness of the tibia. Fore and middle tarsi blackened from the tip of the first joint; anterior pair with their joints as 48–19–12–8–8, first joint with a few slender hairs below; middle basitarsus with numerous bristly hairs below on basal half, which are nearly as long as the diameter of the joint. Hind tarsi wholly black, its joints as 37–30–21–12–8. Calypters brown, with broadly black tips and black cilia; knobs of halteres yellow, with a small brown spot near the base, their stem brownish.

Wings tinged with brownish gray; third vein considerably bent back at tip; last section of fourth vein bent at its middle, parallel with third near the tip; last section of fifth vein twice as long as the cross vein.

Female.—Face broad, gray or yellowish gray; third antennal joint about as long as wide, arista nearly twice as long as the antenna; fore coxae mostly black; all femora and tibiae yellow, with short hair, posterior femora and tibiae usually broadly black at tip. Wings about as in the male.

Redescribed from 29 males and 3 females. I took many in California from March 21 to June 7; Doctor Aldrich took it in Idaho, June 7, and in Washington, June 7 and July 6. It was described from Sitka, Alaska.

2. ARGYRA HIRTA, new species

Male.—Length, 4 mm. Face rather wide, grayish, almost black. Front greenish with gray pollen. Antennae black (fig. 3); first joint with stiff hairs above; third joint but little longer than wide; arista three times as long as the antenna. Palpi black with long black hairs. The minute black orbital cilia scarcely reach down to the middle of the eye, below these the beard is black or brown, not abundant.

Thorax green on the dorsum, its posterior portion and the scutellum with deep blue reflections, the latter with two pairs of marginal bristles, its disk bare; the pollen on the dorsum of the thorax gray and confined to the anterior portion; pleurae black with white pollen. Abdomen wholly green, with coppery reflections and white pollen, which is not silvery. Hypopygium and its appendages (fig. 4) black; outer lamellae rounded at apex and slightly clubbed; inner appendages small.

All coxae and femora black; fore and middle coxae with stiff black hair. Posterior surface of fore femora and lower anterior surface of middle ones with abundant black hair, which is as long as the width of the femora. Fore and middle tibiae yellow, the former with two rows of rather long slender bristles, otherwise with only short hair; middle ones with two rows of bristles above and several smaller ones below. Hind tibiae wholly black, with a row of five moderately long bristles on upper outer edge. Fore and middle tarsi blackish, a little longer than their tibiae; fore tarsi with its joints as 36–9–7–5–7, the first joint with the hairs on its lower edge as long as its diameter. Middle tarsi with the first joint as long as the remaining four taken together; fourth and fifth of equal length. Hind tarsi wholly black, the joints as 40–26–17–12–10, the first joint a little arched. Calypters brown with black tips and cilia; halteres yellow.

Wings a little tinged with brown; third vein only a little bent back at its tip; last section of fourth vein bent at its middle, parallel with third beyond this bend, ending in the apex of the wing; last section of fifth vein about twice as long as the crossvein.

Described from one male taken by Dr. J. M. Aldrich at Tennessee Pass, Colorado, July 24, 1917.

Type.—Male, Cat. No. 27034, U.S.N.M.

This differs from both *nigripes* Loew and *barbipes*, new species, in having the hypopygial lamellae broadly rounded at tip, the third antennal joint shorter and in the proportional length of the joints of fore and hind tarsi.

3. ARGYRA CYLINDRICA Loew

Argyra cylindrica Loew, Smiths. Misc. Coll., No. 171, p. 132, 1864.

Male.—Length, 4.5 mm. Face moderately wide, silvery white. Front green with white pollen: palpi and proboscis black. Antennae (fig. 2) black; first joint with four stiff hairs above; third joint scarcely longer than the two basal joints together; arista fully three times as long as the antenna. Lower orbital cilia and the beard sordid white; the small black upper cilia reach down nearly to the middle of the eye.

Dorsum of thorax green with gray pollen in front and on the sides; scutellum with two pair of marginal bristles. Abdomen dark green, dulled with gray pollen, which is scarcely thicker on the sides and leaves a median blackish stripe in certain lights. Hypopygium (fig. 6) and its lamellae black, the latter rather long and narrow, fringed with pale hairs; the tip of the hypopygium is cleft, rounded and yellowish toward the end; inner appendages yellow, small, rounded at tip; they are not visible in the California specimen.

Fore coxae yellow, blackened at extreme base; middle and hind pairs black; all the hair and bristles of the coxae are black. Fore and middle femora and tibiae wholly yellow; fore femora with long black hair on the posterior surface; middle ones with long black hair on the lower edge of both anterior and posterior surfaces; these are scarcely as long as the width of the femora. Hind femora yellow, their tip black for one-third their length, still the yellow extends to the tip on the lower edge; they have a row of moderately long, delicate hairs on lower outer edge and a few longer black bristles near the tip. Hind tibiae yellow, with the tip becoming brown. Fore and middle tarsi with the first joint brownish, their tips and the following joints black; joints of fore tarsi as 39–16–11–7–7. Hind tarsi wholly black, with the first joint a little longer than the second. Calypters broadly black at tip, their cilia yellowish. Halteres yellow.

Wings tinged with brownish-gray; third vein bent backward at tip; last section of fourth vein bent near its middle, considerably arched, so that it is farther from third vein at tip than at the bend, ending just back of the apex of the wing; last section of fifth vein nearly twice as long as the cross vein.

Female.—Face and front covered with grayish-white pollen; third antennal joint not as long as wide; arista nearly apical, more than three times as long as the antenna; fore coxae yellow; femora yellow with short hair, posterior pair more or less blackened at tip, sometimes almost wholly yellow; all tarsi yellow at base; hind tibiae infuscated at extreme tip only. Wings with the third and fourth veins parallel toward their tips; last section of fifth vein twice as long as the cross vein. Cilia of the calypters black. The pollen of the thorax and abdomen is more white, not gray as in the male; that of the abdomen is confined to the sides.

Redescribed from 4 males and 10 females. Doctor Aldrich took 2 males and 4 females in Washington, May 13, to July 6; all the rest were taken by him and myself in California from April 13 to May 16. This was described from Alaska.

4. **ARGYRA ANGUSTATA, new species**

Male.—Length, 4 mm. Slender, wholly dark green, with little white pollen, and wholly yellow tibiae, femora, and fore coxae.

Face and front silvery white, the former quite wide. Palpi and proboscis black. Antennae (fig. 5) black; first joint short; I can see only one hair on its upper edge; third joint nearly three times as long as the two basal joints together; arista nearly apical, scarcely as long as the antenna. Orbital cilia wholly pale, except two or three very small black hairs at the top of the eye.

Dorsum of the thorax and the slender abdomen dark shining green, fore part of the thorax with a little white pollen; scutellum with four large marginal bristles; pleurae blackish with white pollen; hairs on the sides of the first four abdominal segments yellowish. Hypopygium (fig. 7) black or testaceous, the apical half shining and cleft at the apex; outer lamellae yellow and fringed with hair above; I do not see any inner appendages, except the long black central filament and its yellow sheath.

Fore coxae wholly pale yellow; middle and hind coxae yellow, the latter a little, the former largely, infuscated on outer surface. All femora and tibiae wholly yellow. Fore and middle femora with long, delicate, yellow hairs below. All tarsi infuscated from the tip of the first joint; first joint of posterior pair brownish-yellow, as long as the second joint. Fore tarsi one and a half, middle ones one and a fourth times as long as their tibiae; joints of anterior pair as 54–20–13–13–9. Middle basitarsus as long as the three following joints taken together. Calypters and halteres yellow, the former with a brown tip and yellow cilia.

Wings nearly hyaline; third vein bent backward at tip; last section of fourth vein a little bent at its middle, parallel with third beyond this bend, ending just back of the tip of the wing; last section of fifth vein not quite one and a half times as long as the cross vein.

Female.—Color of the thorax, abdomen, legs, and tarsi as in the male; face very narrow for a female, about as wide as in the male; face and front silvery white; hairs of the abdomen black, but appearing reddish in certain lights. Those of the male also appear to have a reddish cast. The coxae are yellow with black bristles, the anterior pair a little blackened at extreme base; hairs on the lower surface of all femora yellow, those on anterior pair quite long, those on middle and hind pairs very short. Wings as in the male, except that the bend on the last section of fourth vein is a little nearer the crossvein and the fourth vein ends in the apex of the wing. Joints of fore tarsi as 39–28–18–9–7; middle ones 50–22–15–9–6; hind pair 42–15–10–6–7.

Described from five males and one female. Holotype, male was taken at Echo Lake, Mount Desert, Maine, July 17, 1918, by C. W. Johnson and is in the museum of the Boston Society of Natural History; two males were taken at Lake Tear, Essex County, New York, 4,500 feet elevation, July 21, 1920; two males were taken in Polk County, Wisconsin, by C. F. Baker; allotype, female was taken at Olean, New York, August 5, 1917.

Allotype and paratype.—Female and male, Cat. No. 27035, U.S.N.M.

5. ARGYRA BREVIPES, new species

Male.—Length, 3.5 mm. Face not very narrow, silvery white. Front covered with white pollen. Proboscis and palpi black, with black hairs. Antennae black; first joint with a few small hairs above; third nearly as long as the face; arista apical, two-thirds as long as the third joint. Lateral and inferior orbital cilia white.

Thorax greenish-black; when viewed from in front it is opaque with white pollen; scrutellum with one pair of large marginal bristles, disk bare. Abdomen black, covered with silvery white pollen; the hind margins of the segments are narrowly white.

Hypopygium black, quite shining; its appendages almost concealed, but there appear to be small, conical, black, outer lamellae.

Fore coxae wholly yellow, nearly bare, except two or three black bristles near the tip; middle and hind coxae grayish, their bristles black. All femora and tibiae yellow. All femora with only short hair; still there are a few delicate hairs on the posterior surface of the anterior ones which are a little longer; hind femora nearly black at tip. Fore tibiae with two minute bristles; posterior tibiae a little brown at tip. Fore and middle tarsi yellow, a little darker at tip, joints of fore tarsi as 40–12–8–5–6. Hind tarsi wholly black, their joints as 22–20–15–10–10. Calypters pale yellow with a brown tip and yellow cilia; halteres yellow.

Wings grayish; third and fourth veins nearly parallel, the last section of fourth being scarcely at all bent; last section of fifth vein twice as long as the crossvein.

Described from one male taken at Opelousas, Louisiana, April, 1897, by G. R. Pilate.

Type.—Male, Cat. No. 27036, U.S.N.M.

6. ARGYRA BARBIPES, new species

Male.—Length, 3.5 mm. Face wide, covered with whitish pollen. Front green with a little white pollen. Palpi and proboscis black with black hairs. Antennae black; first joint with strong hairs above; third joint as long as the two first taken together, rounded at tip; arista nearly apical, rather thick, scarcely as long as the

antenna. Lower orbital cilia whitish, the minute upper cilia black and descending to about upper third of the eye.

Thorax dark, shining green, its silvery white pollen confined to a spot on each side near the humeri; pleurae more black, with white pollen. Abdomen with the two first and part of the third segment green, the remainder dark coppery, last segment short, black. Hypopygium (fig. 8) black; the outer lamellae triangular, yellowish-brown; inner appendages small.

All coxae and femora black. Fore and middle coxae with black hair and bristles. Fore femora and tibiae with long, fine hair on posterior surface, the hairs as long as the basitarsus; these hairs appear black or reddish according to the light in which they are viewed. Middle femora with a row of stout hairs below, which are longest in the middle, still none are as long as the width of the femora; they do not reach the base but extend to the tip; hind femora nearly bare below. Fore and middle tibiae yellow, rather short and stout, of nearly equal length, middle ones with a row of short, stout hairs below, which are longer near the tip. Hind tibiae black, still they are a little yellow above at base, and sometimes the yellow extends nearly to their middle; their hair short. Fore and middle tarsi brown, a little yellowish at base and black at tip, the front ones longer than their tibiae and with their joints as 24–10–8–6–5. Middle tibia and tarsus with the joints as tibia, 56, tarsi, 44–19–12–6–7. Hind tarsus with its joints as 25–22–16–10–8. Calypters brown, their edge and cilia yellowish. Halteres yellow.

Wings a little tinged with brown; third vein slightly bent back at tip; last section of fourth vein only a little bent at its middle, parallel with third near the tip, ending in the apex of the wing; last section of fifth vein nearly twice as long as the crossvein.

Female.—Face wide, gray; first antennal joint rather long, equal to third in length; arista a little longer than the antenna; fore coxae a little yellowish at tip. All femora and tibiae yellow, the posterior femora and tibiae rather broadly black at tip; fore tarsi almost wholly yellow, hind tarsi wholly black, with the first and second joints of nearly equal length. Abdomen bright shining green; last section of fourth vein more bent than in the male.

Described from one pair taken by Dr. J. M. Aldrich at Redwood City, California, April 7, 1906, and two males which I took at Berkeley, California, May 16 and 18, 1915.

Type and allotype.—Cat. No. 27037, U.S.N.M., from Redwood City.

7. ARGYRA SCUTELLARIS, new species

Male.—Length, 5.6 mm. Face, front, and palpi velvety black; face wide; palpi with black hair. Antennae (fig. 10) black; first joint with numerous hairs on upper edge and four below; third

joint not longer than the two first taken together, rounded at tip; arista inserted above the tip, about as long as the antenna. Orbital cilia black; still, some of the lower ones more brownish in certain lights.

Dorsum of thorax green, dulled with brownish pollen, which leaves a brown stripe on each side of the acrostichal bristles; humeri with numerous bristlelike hairs; scutellum with two pairs of marginal bristles and conspicuous, rather long, black hair on its disk. Abdomen green, covered with silvery white pollen, except the first segment, which has long, black hair on the sides; second segment with even longer black hairs or bristles on the sides of the hind margin; all the hair on the abdomen long and black. Hypopygium (fig. 9) black; its outer lamellae black, more or less yellow at base, and with long black hairs; inner appendages are a pair of rather small, black, nearly straight organs and a pair of large yellow lamellae with a yellow hair at tip; these are much larger than the narrow outer lamellae.

All coxae black, tips of the anterior pair yellow; fore and middle pairs with long, stiff, black hairs, which are as long as their thickness; posterior pair with two bristles and several hairs on outer surface. All femora yellow; in one specimen all the femora are a little blackened at extreme base, in another the fore femora are blackened at base on lower posterior edge for more than one-third their length, the other femora being wholly yellow. All femora with long black hair, that on the fore pair on the lower and posterior surfaces and that on the others on the anterior surface, especially below. All tibiae wholly yellow, with strong bristles. All tarsi black from the second joint, first joint of fore tarsi with minute bristles or stiff hairs below, its joints as 58–16–10–8–11. Middle tarsi with its joints as 59–26–18–10–10. Joints of hind tarsi as 49–35–23–10–11. Calypters whitish at base, apical half black, their cilia long and black. Halteres yellow.

Wings grayish; third vein bent backward at tip; last section of fourth vein quite abruptly bent before its middle, parallel with third at tip; last section of fifth vein scarcely one and a half times as long as the crossvein.

Female.—Face wide, its suture nearly straight, pollen of the face yellowish-gray; lower line of the face a little pointed in the middle; third antennal joint about as long as wide; arista longer than the antenna; hairs on the scutellum conspicuous; pollen of the thorax rather thick, gray; all femora and tibiae wholly yellow. First joint of hind tarsi yellow with a black tip, longer than the second joint.

Described from two males taken by F. R. Cole at Forest Grove, Oregon, May 5, 1918; and one female taken at Grangeville, Idaho, by Dr. J. M. Aldrich.

This species is remarkable for the conspicuous hair on the disk of the scutellum, the long, bristle-like hair on the coxae and femora, and the large, lamella-like inner appendages of the hypopygium of the male.

Type and *allotype*.—Male and female, Cat. No. 27038, U.S.N.M.

8. ARGYRA NIGRIVENTRIS, new species

Type and allotype.—Male and female, Cat. No. 27038, U.S.N.M. former moderately wide. Palpi and proboscis black, with black hairs. Antennae black; first joint with about four hairs above; third joint a little longer than the two first taken together, pointed at tip; arista inserted a little before the tip, about as long as the antenna. Lower orbital cilia white; the minute black upper cilia descend to the middle of the eye.

Dorsum of thorax dark shining green, or blue green, covered with quite abundant silvery white pollen, especially on the anterior half; pleurae more black with white pollen; scutellum with two pair of large marginal bristles. Abdomen black; all but the first segment covered with thick silvery white pollen; first segment and sides of the others with green reflections; hairs and bristles on the abdomen black, those on the last two segments appear reddish in certain lights. Hypopygium (fig. 11) black, small; its outer lamellae black, somewhat triangular, fringed with reddish hairs; the inner appendages are a central yellow organ, a pair of lamella-like organs with several hairs, and a pair of rather slender organs tipped with a minute bristle.

All coxae black, with black hairs and bristles; anterior pair with a row of long slender bristles besides those at tip; these are longer than the thickness of the coxa. Fore femora black with yellowish tips; they have moderately abundant, long, black hair on posterior surface. Middle femora with long hairs on the lower surface, not as long as the width of the femora. Fore and middle tibiae and basitarsi yellow; joints of fore tarsi as 38–10–8–5–6. Posterior femora, tibiae, and tarsi wholly black; lower surface of hind tibiae clothed with long, delicate hairs, which are about as long as the small bristles on upper surface; these hairs are black but appear reddish in certain lights; joints of hind tarsi as 59–18–15–7–8. Hind basitarsus a little thickened at base, fringed on each side of lower surface with long bristly hairs, the longest of which near the base are longer than the second joint and appear reddish in certain lights. Calypters dark yellow with black tips, their cilia black or reddish. Knobs of halteres yellow, stems brown.

Wings grayish, slightly tinged with brown in front of third vein; third vein bent backward a litle at tip; last section of fourth vein

a little bent just before its middle, parallel with third at tip; last section of fifth vein one and a half times as long as the crossvein.

Female.—Face and front moderately wide, silvery white; third antennal joint longer than wide, arista nearly apical; lower orbital cilia yellowish, reaching to the middle of the eye; thorax and scutellum as in the male, except that the former has less pollen; abdomen wholly black with slight bronze reflections, its hair as in the male; fore coxae black with apical half a little yellowish, its hairs and bristles black; all femora and tibiae yellow, the posterior femora and tibiae blackened at tip; middle femora with a preapical brown spot above; fore and middle tarsi black from the tip of the first joint, which is half or more than half as long as their tibiae; hind tarsi black, first joint twice as long as second and with minute bristles below, especially at base. Calypters, their cilia and the wings as in the male, except that the wings are more brownish, and last section of fifth vein is fully twice as long as the crossvein.

Described from one pair taken at Lake Cushman, Mason County, Washington, July 15, 1919, by F. M. Gaige; one male (the type, in my collection) taken by E. P. Van Duzee, at Forks, Clallam County, Washington, July 4, 1920; two females taken by J. M. Aldrich, Funday Harbor, Washington, May 30, 1906, and Longmires Springs, Washington, August 2, 1905.

Paratype.—Female; Cat. No. 27039, U.S.N.M.

9. ARGYRA ARGENTIVENTRIS, new species

Male.—Length, 4.2 mm. Face and front silvery white; face quite narrow. Palpi brown, more or less yellow on apical half and with yellow hairs. Antennae black; first joint with several hairs above; third joint as long as first two together, its point obtuse; arista inserted a little before the tip of third joint, as long as the antenna; lower orbital cilia yellowish.

Thorax green with abundant silvery pollen; acrostichal bristles large; in front they are in two rows, but the three posterior bristles are in a single row. Abdomen blackish with green reflections, wholly covered with silvery pollen; the sides of the second segment, except the hind margin and the extreme base of first and third segments, are slightly yellowish. Hypopygium (fig. 24) black, small, its outer lamellae yellowish-brown, rounded at tip; inner appendages black, rounded, with a minute spine at tip.

Fore coxae yellowish, brown on outer surface; they have a few short black hairs on anterior surface and four black bristles near the tip; middle and hind coxae blackish. Femora yellow, a little more than apical third of posterior pair black; fore femora with black hairs on posterior surface, which are as long as the thickness of the femora; middle femora with the hairs near the lower edge

becoming longer and with three small bristles on lower anterior edge near the tip. Fore and middle tibiae yellow, with short hair and small bristles. Hind tibiae brown with long hair, especially below. Fore and middle tarsi yellow, darkened toward their tips; joints of fore pair as 66–22–18–12–10. Hind tarsi brownish; first joint thickened, especially at base, with two rows of long bristles below; joints of hind tarsi as 105–40–30–19–18. Calypters and halteres yellow, the former with their tips slightly brown and their cilia black.

Wings dark grayish; third vein bent backward at tip; last section of fourth vein bent before its middle, parallel with third beyond the bend; last section of fifth vein nearly twice as long as the crossvein.

Described from two males taken by Dr. J. M. Aldrich, at Mono Lake, California, July 22, 1911.

This is the fourth species to be described from America that has the first joint of hind tarsi much longer than the second and furnished with long bristles.

Type.—Male, Cat. No. 27040, U.S.N.M.

10. ARGYRA FEMORALIS, new species

Male.—Length, 3.5 mm. Face, front, palpi, and proboscis black; still in certain lights they show a little brownish-gray pollen; face rather wide for a male. Antennae black, first joint with conspicuous hairs above; third joint about as long as the basal two taken together, obtusely pointed; arista inserted just above the point, scarcely as long as the antenna. Lower orbital cilia grayish; the small, black, upper cilia reach down about one-fourth the eye height.

Dorsum of the thorax dark, shining green, its silvery pollen confined to a band extending from below the humeri to, and a little above, the root of the wing; scutellum with two pairs of marginal bristles, the outer pair about half as large as the median ones. Abdomen metallic green with the third and following segments covered with abundant silvery pollen, its hairs and bristles wholly black. Hypopygium small, black; outer lamellae small, black, obtuse at tip and fringed with hairs; inner appendages are a pair of yellow, slightly clubbed, short organs, with two or three short hairs at tip.

Coxae black with black hairs and bristles, fore coxae yellow at tip and with a row of slender bristles on apical half of outer anterior edge, which are longest above, where they are as long as the thickness of the coxa. All femora and tarsi black, extreme tips of femora yellow; anterior femora with long, black hair on the posterior surface; middle pair (fig. 12) with a protuberance below, where there are a few close-set, short spines; hind femora with long, black hair

on lower, outer edge, which is not as long as their width. Fore and middle tibiae yellow, the latter slightly swollen on anterior surface near the middle and again at tip; on the middle swelling are about 10 hairs, which are much longer than the thickness of the tibia. Hind tibiae with basal half yellowish, apical half black, sometimes the basal half is darker below. Fore tarsus with its joints as 39–14–10–7–7, first joint with a few bristles below; middle tarsus with its joints as 50–19–17–9–8; joints of hind tarsus as 32–28–20–12–8. Calypters brown with a black border and long, black cilia. Halteres yellow.

Wings grayish; third vein bent backward at tip; last section of fourth vein a little bent before its middle, parallel with third beyond this bend, ending in the apex of the wing; last section of the fifth vein one and a half times as long as the crossvein.

Female.—Face wide, its suture below the middle; lower edge of face rounded; face, front, palpi, and proboscis covered with gray (some might call it yellowish-gray) pollen. Third antennal joint scarcely as long as wide; arista subapical, longer than the antenna. Coxae as in the male; all femora and tibiae yellow; posterior femora and tibiae with apical fourth to apical half black; femora with only short hair; middle femora and tibiae plain.

Abdomen with the white pollen confined to the lower part of the sides.

Wings as in the male.

Described from two males and three females which I took in California; one male at Los Angeles, April 30; one male and two females at Alpine, San Diego County, April 8 and 10; and one female at Los Cerritos, Los Angeles County, April 3.

Type.—Male, Cat. No. 27041, U.S.N.M.

11. ARGYRA ALBIVENTRIS Loew

Argyra albiventris Loew, Smiths. Misc. Coll., No. 171, p. 128, 1864.

Joints of front tarsi, measured from a small specimen (4.5 mm.) as 40–16–10–7–7; measured from a large specimen (6 mm.) are as 43–20–12–8–8; joints of the posterior tarsi from a small specimen as 36–33–20–12–9, measured from a large specimen they are as 40–35–25–15–11. There are only very small bristles on the lower surface of the first joint of anterior pair, not much more than hairs. Calypters mostly black, their cilia black.

Described from Sitka, Alaska. Have seen specimens from the following locations: Hood River, Oregon, September 28, taken by F. R. Cole; Seattle and Dewatto, Washington, June 7. J. M. Aldrich took it in the following places in Idaho: Juliaetta, June 16; Viola, June 29; Bovill, July 15; and in Craigs Mountain.

12. ARGYRA ROBUSTA Johnson

Argyra robusta JOHNSON, Psyche, vol. 13, p. 59, June, 1906.

Male.—Length, 6–7 mm. Face wide; silvery white. Palpi black, with black hairs. Front covered with white pollen. Antennae black; first joint with stiff hairs above; third joint about twice as long as wide; arista subapical, as long as the antenna. Beard grayish-white, abundant.

Thorax dark green with considerable grayish-white pollen; scutellum with many long, black hairs on the disk and four large, marginal bristles. Abdomen black, second and third segments with large yellow spots on the sides, those on second only leave a narrow black margin on anterior and posterior edges and a wide median stripe. Abdomen covered with silvery white pollen, all its hairs black. Hypopygial lamellae rather narrow and curved, yellow at base, more or less black at tip, fringed with black hairs; back of these is a long yellowish portion of the hypopygium.

All coxae black with black hair and bristles. All femora black with their tips narrowly yellow, anterior pair with long black hair on the posterior surface; middle pair with moderately long hair below; posterior pair with several bristlelike hairs near the tip. All tibiae yellow, extreme tips of hind pair brownish. Fore and middle tarsi infuscated from the tip of the first joint, still the other joints paler at base; hind tarsi black with the first joint yellowish at base. Joints of fore tarsi as 50–17–15–8–10; first joint with conspicuous bristles below, which are as long as the diameter of the joint; middle tarsi with the joints as 62–24–19–10–12; those of hind tarsi as 49–35–27–20–14. Calypters white with a black border and yellowish cilia. Halteres yellow.

Wings grayish, slightly tinged with brown in front and along the veins; third vein bent back at tip; last section of fourth vein bent at its middle, parallel with third at tip; last section of fifth vein one and a half times as long as the cross vein.

Female.—Differs from the male in having the pollen of the thorax and abdomen more brownish; the face wide and more gray, or grayish-yellow; its suture far below the middle, sinuous; lower edge of the face rounded; third antennal joint about as long as wide, arista apical. Fore and middle femora more or less blackened at base, sometimes largely black, their hair shorter than in the male; hind femora wholly yellow. All tibiae yellow. Hind tarsi usually wholly black; still sometimes the first joint is yellow with a black tip.

This species differs from *albiventris* Loew chiefly in having hair on the scutellum and in the proportionate length of the joints of the tarsi and the bristles on the lower surface of the fore tarsi; in

robusta these bristles are as long as the diameter of the joint and very conspicuous, while in *albiventris* there are only very small bristles, if indeed they could be called bristles, they are but little longer than the hairs on other portions of the joint. *A. robusta* is a much larger species and the female is much stouter than that of *albiventris*.

Redescribed from many males and females taken at Hull, Quebec, where the type specimen was taken. Have seen specimens taken by Doctor Aldrich at Craigs Mountain, Idaho, May 24, 1902. One male taken at Algonquin, Illinois, June 6, 1895. Two males taken in South Dakota; one male taken at Bozeman, Montana, June 20, 1911; and one male taken at Portage, New York, July 1, 1917.

13. ARGYRA CILIATA Van Duzee

Argyra ciliata VAN DUZEE, Proc. U. S. Nat. Mus., vol. 63, art. 21, p. 5, 1923.

This was described from one pair taken by Doctor Aldrich at Fairbanks, Alaska.

Type.—Male, Cat. No. 25958, U.S.N.M.

14. ARGYRA BIMACULATA, new species

Male.—Length, 4.7–5 mm. Face rather wide, silvery white. Front thickly covered with white pollen. Antennae black; first joint with numerous stiff hairs above; third joint nearly three times as long as broad; arista apical, about as long as third joint. The small black orbital cilia do not reach down to the middle of the eye. Beard yellowish, not abundant.

Dorsum of the thorax green with rather thick yellowish-white pollen; pleurae black with white pollen; scutellum with four large marginal bristles, and with a few conspicuous black hairs on its disk. Abdomen green with its hair and bristles black; second segment with a rather large, third with a small yellowish spot on each side; still, these spots are not conspicuous; abdomen with a narrow line of white pollen at the base of each segment, and some yellowish-brown pollen visible in certain lights on the dorsum. Hypopygium (fig. 14) black; outer lamellae small, black, somewhat triangular; inner appendages testaceous, large, shining, nearly bare, still having several small hairs.

Coxae black, fore and middle ones with numerous black, bristly hairs. All femora black, fore and middle ones narrowly yellow at tip; anterior pair with long black hair on posterior surface, which is about as long as the thickness of the femora; middle pair with a row of black bristly hairs on lower anterior edge, which are not as long as the width of the femora. All tibiae yellow, posterior pair black at tip, this black shading into the yellow. Fore

and middle tarsi black from the tip of the first joint, hind ones wholly black. Joints of fore tarsi as 44–14–10–8–10; those of middle ones as 53–22–15–8–8; of hind tarsi as 36–29–12–11–9. Calypters yellow with broad black tips and yellowish cilia. Halteres yellow.

Wings very slightly tinged with brown in front; third vein very gently arched; last section of fourth vein bent a little beyond its basal third, parallel with third beyond the bend; last section of fifth vein nearly twice as long as the cross vein.

Female.—What is no doubt the female of this species has the face wide, silvery white, its suture low down, making the lower part of the face about half as long as wide, with the lower edge a little rounded. Front covered with white pollen. Scutellum with a few minute, black hairs on the disk; abdomen green, sometimes purple, venter yellow at base. All coxae black. Fore and middle femora largely black, hind pair yellow with apical third black. Hind tibiae broadly black at tip; fore tibiae with strong bristles above, none below.

Described from eight males and three females taken at Hull, Quebec, June 11–15, by C. H. Curran; two females taken by Doctor Aldrich in South Dakota, and one female at Algonquin, Illinois, May 15, 1894.

Holotype male and allotype female were taken at Hull, Quebec, and are in the Canadian National Museum.

Paratypes.—Male and female, Cat. No. 27042, U.S.N.M.

15. ARGYRA VELUTINA, new species

Male.—Length, 6 mm. Face, palpi, front and occiput velvety black, the latter with a white sheen when viewed in certain lights; face moderately narrow, the sides parallel; palpi with conspicuous black hairs. Antennae black; third joint about as long as the basal two taken together, somewhat triangular, pointed at tip; first joint with numerous hairs above; arista apical, as long as the antenna. Orbital cilia and beard wholly black.

Thorax blackish, somewhat shining, dorsum with thin brown pollen; scutellum with four large marginal bristles and numerous black hairs on its disk. Abdomen and its hairs black; first and second segments with large yellow spots on each side, which leave only narrow anterior, posterior, and median lines of black; fourth segment with a yellow spot on each side on anterior margin. Hypopygium and its appendages black, its outer lamellae and inner appendages somewhat like those of *bimaculata* (fig. 14), except that the lamellae are more angulated in the middle and there is a slender somewhat clubbed organ inside of the large ones shown in the figure.

All coxae and femora black; fore and middle coxae with long black hair; fore femora with long black hair on the posterior and lower surfaces; middle pair with long black hair below, which is as long as their width. All tibiae and basitarsi yellow, all tarsi black from the extreme tip of first joint; joints of fore tarsi as 50–14–10–9–7; of middle tarsi as 56–25–15–8–10; joints of posterior pair as 44–35–22–15–8. Calypters whitish with black tips and cilia. Halteres yellow.

Wings grayish; third vein bent backward at tip, parallel with fourth beyond the bend in the last section of the latter; last section of fifth vein nearly one and three-fourths times as long as the crossvein and fully as long as from the crossvein to the bend of the fourth, which is quite abrupt.

Female.—Front and face wide, thickly covered with grayish yellow pollen, the latter with the suture far down so that the lower portion is scarcely half as long as wide; arista apical. Coxae and their hairs wholly black; femora and tibiae yellow; fore and middle femora a little darkened at base, the former also blackened on upper surface; hind femora slightly blackened above at tip. Hind tibiae wholly yellow; fore and middle tarsi black from the tip of first joint; first joint of hind tarsi yellowish-brown. Cilia of the calypters long and black. Hairs on the surface of the scutellum conspicuous, but not as long as in the male.

Described from one pair taken by C. H. Curran at Hull, Quebec, June 4, 1923.

Type and allotype.—In Canadian National Collection.

16. ARGYRA SPLENDIDA, new species

Male.—Length, 5 mm. Face and front silvery white, the former rather narrow; palpi and proboscis black with black hairs. Antennae black; first joint with conspicuous hairs above; third joint as long as the first two taken together, obtusely pointed at tip; arista above the point, a little longer than the antenna. The minute, black, orbital cilia descend to the middle of the eye; below them the beard is white or yellowish-white, and quite abundant.

Dorsum of the thorax green with brown reflections and a violet stripe on each side of the long acrostichal bristles; these stripes do not reach either the front of the thorax or the scutellum; the dorsum dulled with gray pollen, which is most abundant on the anterior half and on the violet stripes; the pollen on the sides is more silvery white; scutellum with two pairs of marginal bristles, outer pair not more than half as long as the median ones; there are several small, pale hairs above the fore coxae; pleurae black with white pollen. Abdomen black, wholly covered with silvery white pollen; there are large yellow spots on the sides of the second and third segments and

the first is a little yellow on the sides at the posterior margin; fourth segment with a rather small yellow spot on each side at the anterior margin; hairs and bristles of the abdomen wholly black. Hypopygium (fig. 21) and its appendages wholly black, except two small pointed appendanges below the outer lamellae and a central filament, which are yellow; outer lamellae rather small.

Coxae black almost to their tips, their hair and bristles wholly black, anterior pair with a row of long slender bristles or hairs from their tips almost to the base. Fore femora black with base, tip and apical half of lower surface yellow; middle pair yellow with basal third slightly brownish below; posterior pair yellow, blackened above on apical half or more, posterior surface of fore femora with abundant long, black hair; middle femora with two rows of long black hairs on lower anterior surface and one row of still longer black or brown hairs on lower posterior surface. All tibiae yellow, tips of posterior pair slightly darker. Fore and middle tarsi blackened from the second joint; fore tarsi with its joints as 37–15–12–9–9; joints of middle tarsi as 59–27–18–11–10. Hind tarsi wholly black, its joints as 40–39–22–13–9. Calypters yellow with broad black tips and black cilia.

Wings grayish, veins slightly bordered with brown; third vein considerably bent backward at tip; last section of fourth vein bent before its middle; parallel with third at tip, ending nearly as far back of the apex of the wing as the third vein does before that point; last section of fifth vein one and one-third times as long as the crossvein.

Described from one male which I took at Berkeley, California, May 15, 1915. Type in the author's collection.

This form is very much like *californica*, new species, in the form of the hypopygium and its appendages and in general color. It differs in being larger, in the color of the femora, in the proportionate length of the joints of the tarsi; the fore coxae are not at all yellow, except at tip; the first abdominal segment has a little yellow on its sides, and the last section of the fourth vein of the wings is a little more bent, the bend is also a little nearer the crossvein.

17. ARGYRA ALBICANS Loew

Argyra albicans Loew, Neue Beitr., vol. 8, p. 45, 1861; Smiths. Misc. Coll., No. 171, p. 125, 1864.

The joints of the fore tarsi in this species are as 58–16–10–7–9; those of middle tarsi are as 62–26–19–10–9; and those of posterior tarsi as 35–37–25–12–10.

This is an abundant species in the Eastern States; it was described from Washington, District of Columbia. I have seen specimens from Cohasset, Massachusetts, taken May 29; Blue Hills, Massachusetts, July 16; Auburndale, Massachusetts, August 13; Middletown, Con-

necticut, June 7; Falls Church, Virginia, May 16; Erie County, New York, June to August; Portage, New York, July 4; Lake Pipin, Ohio, September 1; Philadelphia, Pennsylvania, September 5; Polk County, Wisconsin, July; Lafayette, Indiana, May to July; Lawrence, Kansas, May 12; Opelousas, Louisiana, March; and Niagara Falls, Ontario, October 10.

This species has a few distinct, but small hairs on the disk of the scutellum; *robusta* Johnson has even more hair on the disk of the scutellum and the hairs are longer; in *scutellaris*, new species, the hair on the disk is still longer and more abundant. The male of *bimaculata*, new species, has more conspicuous hair on the disk of the scutellum than this species has, but the female has only a few small hairs as in the female of *albicans*. The male of *nigricoxa*, new species, has a few small hairs on the disk of the scutellum, about as in the male of *albicans*. The male of *sericata* also has a very few minute black hairs on the disk of the scutellum.

18. ARGYRA THORACICA, new species

Male.—Length, 5–6 mm. Face and front wide, silvery white. Palpi and proboscis black, with a little white pollen. Antennae black; first joint with conspicuous hairs above; third joint not quite as long as the face, rounded at tip; arista nearly apical, scarcely as long as the third joint. Lower orbital cilia and the beard white, about 10 of the small upper cilia on each side black.

Dorsum of the thorax so thickly covered with silvery white pollen as to conceal the ground color, except a large spot of shining green before the scutellum; scutellum more blue, dulled with white pollen, with two pairs of large marginal bristles. Abdomen with the second and third segments yellow, with narrow black hind margins; first segment yellowish with a black apical border, sometimes wholly black, and with long black bristles on the whole hind margin and a cluster of moderately long black hair on each side; fourth segment black with a yellowish basal spot on each side; fifth and sixth segments wholly black; abdomen from near the base of second segment covered with silvery white pollen, which is thickest on sixth; all hairs and bristles on the abdomen black, extreme edges of all segments white. Hypopygium (fig. 16) more or less yellowish at base, black on outer surface, sometimes wholly black; outer lamellae yellow, rather slender, abruptly tapering into a point from apical third; inner appendages are a pair of yellow organs of nearly equal width throughout and a little obliquely cut off at tip, inside of these is a blackish organ which is a little notched at tip.

Fore coxae yellow, usually with a brown spot at base on outer side; middle and hind coxae black, their tips and inner surface yel-

low; fore and middle coxae with a row of black bristles on outer anterior edge, their hairs black. All femora yellow, posterior pair with their tips more or less blackened for one-fourth their length and with a preapical bristle; fore femora with a fringe of reddish hair on lower posterior edge, the longest being on apical half, where the hairs are nearly as long as the width of the femora. All tibiae yellow, posterior pair often brownish-yellow, their tips black, the black shading into the yellow and usually reaching nearly to the base below. Fore and middle tarsi almost wholly yellow; joints of fore tarsi as 52–24–10–9–8; of middle tarsi as 64–32–25–13–8. Hind tarsi wholly black, their joints as 38–42–31–17–12. Calypters whitish with a narrow black edge and yellow cilia. Halteres yellow.

Wings grayish, veins yellowish-brown; third vein scarcely bent backward at tip; last section of fourth vein bent distinctly before its middle, parallel with third at tip; last section of fifth vein not quite one and a half times as long as the cross vein.

Female.—Agrees with the male in the characters of the head, abdomen, and wings, except that the third antennal joint is only a little longer than wide, the second joint extends over the upper edge of third nearly to its tip; arista almost as long as the face; the abdomen has very little white pollen; the first segment is wholly black; second, yellow with the posterior margin very narrowly black; third, yellow with broad hind margin and median line black; fourth segment with only a small yellowish spot on each side at lower anterior corner.

Thorax and scutellum green, considerably dulled with silvery white pollen. Coxae as in the male; hind femora wholly yellow; hind tibiae yellow with apical third black; fore and middle tarsi blackened toward their tips.

Described from seven males and four females. Two males were taken at Kearney, Ontario, July 3, 1909; one at Lewiston, New York, June 17, 1917; one at Gowanda, New York, June 8, 1913; one at Colden, Erie County, New York, June 7, 1908; one at Kiamesha, New York; and one from Speculator, New York, June 13. One female was taken at Protection, Erie County, New York, June 16, 1918, and one from Newport, New York, June 22.

Type.—Male, Cat. No. 27043, U.S.N.M., Kearney, Ontario.

19. ARGYRA CURRANI, new species

Male.—Length, 5 mm. Face and front silvery white, the former moderately wide, narrowed a little below. Palpi black, covered with white pollen. Antennae black, first joint nearly as long as third, and with conspicuous hairs above; third joint about twice as long as wide, obtusely pointed at tip; arista nearly apical, as

long as second and third antennal joints taken together. The black upper orbital cilia do not reach down to the middle of the eye; beard snow white.

Dorsum of thorax green, anterior half with considerable white pollen; pleurae wholly blackish with white pollen, its posterior edge not at all yellow; scutellum with four marginal bristles, without hairs on the disk. Abdomen dark metallic coppery; second and third segments yellow, except narrow hind margins and a wider median line, which are of a blackish-coppery color; fourth segment with a yellowish spot on each side; hairs of the abdomen wholly black. Hypopygium and its appendages wholly black, the former with numerous long, black, bristly hairs on posterior surface; outer lamellae small, acute, triangular.

Fore coxae pale yellow, covered with silvery white pollen, their anterior surface with a few minute black hairs and several long slender bristles near the tip; middle and hind coxae black, narrowly yellow at tip. Femora and tibiae yellow, tips of posterior tibiae narrowly but sharply black. Fore femora with a few long black hairs on upper posterior surface of apical half, otherwise the hairs on all femora are short and black. Fore and middle tarsi blackened from the tip of the first joint, hind tarsi wholly black; joints of fore tarsi as 45–18–12–8–8; of middle pair as 55–25–16–9–8; those of hind tarsi as 39–34–23–13–11. Calypters and halteres yellow, the former with a small brown spot at tip and whitish cilia.

Wings grayish; third vein only a little bent back at tip; last section of fourth vein bent just beyond its basal third, parallel with third beyond this bend; last section of fifth vein twice as long as the cross vein.

Female.—Face wide, its sides parallel, silvery white, the suture near the third fifth, making the upper portion longer than the lower part. First antennal joint slightly longer than the second and third taken together; arista a little longer than the antenna; palpi and front black, quite thickly covered with white pollen. Coxae, femora, tibiae, and tarsi colored as in the male, black hairs on the fore coxae about as in the male.

Abdomen shining green or coppery, its sides with white pollen; second abdominal segment with quite large and distinct yellow spots on each side.

Described from eleven males and twelve females, taken at Hull, Quebec, June 6–15, 1923; one female taken at Orillia, Ontario, July 15; and one female taken at Seabright, Ontario, July 16. All taken by C. H. Curran.

Paratypes.—Male and female, Cat. No. 27044, U.S.N.M.

20. ARGYRA NIGRICOXA, new species

Male.—Length 5 mm. Face not very narrow, silvery white. Palpi velvety black with black hairs. Front black with white pollen, which is very thick next to the antennae. Antennae black; first joint hairy above; third twice as long as wide, slightly hollowed below in outline, obtusely pointed; arista as long as the antenna, inserted above the point of third joint. Lateral and inferior orbital cilia white, the small upper cilia black.

Dorsum of thorax green, considerably dulled with white pollen; scutellum with four large marginal bristles and a few small black hairs on its disk; pleurae more black with abundant white pollen. Abdomen with considerable white pollen; first segment green, a little yellowish at extreme base; second and third mostly yellow with the median line and narrow hind margins green; remaining segments green with a narrow line of white pollen at posterior edge; all hairs and and bristles of the abdomen, even on the yellow venter, black. Hypopygium (fig. 13) and its appendages testaceous; outer lamellae rather narrow, bent, blackish; inner appendages large, yellowish, tipped with a minute bristle.

All coxae almost wholly black; fore coxae with black hair on anterior surface and black bristles at tip and on outer edge of apical half. All femora yellow, posterior brown at tip and with a few longer hairs on lower outer edge near the tip; middle pair with a row of long black bristles on lower posterior edge, which are a little longer than the width of the femora; fore femora with abundant long, black hair on the posterior surface. All tibiae yellow, posterior pair indefinitely blackened at tip. Fore tarsi yellow, darker at tip, their joints as 50–15–11–8–10; first joint with a row of little bristles below, which are about as long as the thickness of the joint. Middle tarsi infuscated from the tip of the first joint. Hind tarsi wholly black, the joints as 39–33–25–12–10. Calypters white with a brown border and white cilia. Halteres pale yellow.

Wings grayish; third vein bent backward at tip; fourth vein bent back slightly to meet the crossvein, last section distinctly bent before its middle, parallel with third beyond this bend, ending in the apex of the wing; last section of fifth vein nearly straight, longer than the crossvein.

Described from one male taken at Sugar Grove, Ohio, May 19.

Type.—Male, Cat. No. 27045, U.S.N.M.

21. ARGYRA CALIFORNICA, new species

Male.—Length, 4 mm. Face and front silvery white, the former rather narrow. Palpi and proboscis black, with black hairs. Antennae black; first joint with conspicuous hairs above; third joint

as long as the first two joints taken together, somewhat rounded at tip; arista inserted above the tip, as long as the antenna. The minute black orbital cilia descend about one-third of the eye height; beard yellowish-white, quite abundant.

Dorsum of the thorax bright green, with bronze reflections, the posterior slope, a more or less distinct line each side of the acrostichal bristles, and sometimes the scutellum more blue, or even violet; acrostichal bristles very long posteriorly, in two distinct rows; scutellum with two pairs of marginal bristles; in the best-preserved specimen there is another small pair between the large median ones; dorsum of thorax with considerable silvery white pollen, which forms four stripes when viewed from in front. Dorsum of abdomen black, wholly covered with silvery white pollen, except the first segment; second and third segments with a large yellow spot on each side, which leaves only narrow margins of black on anterior and posterior edges and a narrow median line; fourth segment also with yellow spots on the sides, but they are smaller and less distinct: venter yellow, except on apical segments; hairs and bristles of the abdomen wholly black, even on the venter. Hypopygium (fig. 23) black, its appendages black, except the base of outer lamellae, two small, pointed appendages back of the lamellae and the central filament.

Fore coxae blackish, still more or less yellowish, especially on inner surface and toward the tip; they have long black hair on anterior surface. Middle and hind coxae and their trochanters black. All femora yellow; anterior pair more or less blackened on posterior surface, and posterior pair black above for one-third of their length; fore femora with long black hair on the posterior surface; middle ones with long black hair on the lower portion of both anterior and posterior surfaces, leaving the lower edge glabrous. All tibiae yellow; posterior pair darkened toward their tips, which are narrowly blackish. Fore and middle tarsi yellow, darkened toward their tips, especially the tips of the joints; fore tarsi with their joints as 38–13–9–6–9; middle ones as 45–21–14–8–7. Hind tarsi wholly deep black, their joints as 33–32–20–12–8. Calypters yellow, with a narrow black border and long black cilia. Halteres yellow.

Wings grayish, sometimes very slightly but uniformly tinged with brown; third vein bent backward a little at tip; last section of fourth vein bent near its middle, parallel with third at tip; last section of fifth vein twice as long as the crossvein.

Female.—Face and front wide, covered with grayish-white pollen. Third antennal joint about as long as wide; arista subapical. Thorax without or with but little blue color. Fore coxae yellow, with silvery white pollen and long black hair on the anterior surface. Abdomen green, with bronze reflections, sometimes more purple, covered with

white pollen. All femora and tibiae yellow; posterior femora a little blackened above at tip and hind tibiae only a very little darker at extreme tip; hind basitarsus mostly yellow, even the base of second joint a little yellowish. Wings about as in the male.

Described from three males and four females which I took in California in 1915—one female at Los Cerritos, Los Angeles County, April 3; one male and two females at Los Angeles, April 29; two males at Los Angeles, May 3–4; and one female at Berkeley, May 8.

Type.—Male, Cat. No. 27046, U.S.N.M.

22. ARGYRA SERICATA, new species

Male.—Length, 4 mm. Face wide; face, front, and occiput covered with silvery white pollen. Palpi velvety black, with a little white pollen. Antennae black, first joint with conspicuous hairs above; second joint as long as wide; third joint as long as the basal two taken together, obtuse at tip; arista subapical, scarcely as long as the antenna. Lower orbital cilia and beard white, longer below, the short upper cilia black.

Dorsum of thorax and the scutellum bright blue-green, with silvery white pollen, which is dense along the front and on the sides of the dorsum; scutellum with two pairs of large marginal bristles and a few small black hairs on the disk; pleurae more black, with dense white pollen. Abdomen black, with bright green reflections, especially on the anterior segments, the apical segment more purple; second segment with a large yellow spot on each side, which leaves a rather broad hind margin and median stripe green; third with a small, less distinct, yellow spot on each side in front; all hairs and bristles on the abdomen black. Hypopygium (fig. 17) shining black, the apical portion more testaceous; outer lamellae black, pointed at tip, fringed with pale hairs; the yellow inner appendages are one clavate organ with two hairs and a pair of smooth, pointed ones.

Fore coxae yellow, with a blackish spot at base, their hairs and bristles black; middle and hind coxae colored like the pleurae, their tips yellow, each with two bristles on outer surface and a few black hairs. Femora and tibiae yellow, with black hair; middle femora with a row of moderately long black hairs below; posterior femora with extreme tips brown, especially on upper surface; hind tibiae black at tip for one-fifth their length; all the tibiae with only short hair. Fore tarsi about one and one-fourth times as long as their tibiae, their joints as 48–18–12–7–9; they are yellow, darker apically; middle tarsi black from the tip of the first joint, their joints as 62–28–19–10–8; hind tarsi wholly black, their joints as 40–35–21–12–10. Calypters yellow, with apical edge black and long yellow cilia. Halteres yellow.

Wings grayish; third vein bent backward a little at tip; last section of fourth vein quite abruptly bent before its middle, parallel with third at tip, ending in the apex of the wing; last section of fifth vein more than twice as long as the cross vein.

Female.—Face and front wide, wholly silvery white. Antennae black; third joint about as long as wide, somewhat round in outline, still the tip is pointed; arista nearly twice as long as the antenna. Thorax shining green, with abundant silvery white pollen on front and along the sides, extending to the scutellum, which is also dulled with white pollen; pleurae more black, with silvery white pollen, its posterior edge narrowly and obscurely yellowish. Abdomen black; second and third segments yellow, with narrow hind margins of black, each segment with a conspicuous spot of silvery white pollen on each side at base. Fore coxae yellow, with a blackish spot at base on outer surface; middle and hind coxae largely black. Hind femora a little blackened at extreme tip above; hind tibiae black at tip for nearly one-fourth their length; still, the black is not sharply defined, but shades into the yellow. Hind tarsi wholly black; fore and middle tarsi only a little darkened toward their tips.

Described from three males and two females; two males (one is the type, in the Boston Society of Natural History) were taken at Machias, Maine, July 22, and one male at Brookline, Massachusetts, May 23; these were taken by C. W. Johnson. The two females were taken in Quebec by C. H. Curran, one the allotype (in Canadian National Collection) at Hull, June 6, 1923, and the other at Rigaud, June 26, 1906.

Paratype.—Male, Cat. No. 27047, U.S.N.M., from Machias, Maine.

23. ARGYRA CALCEATA Loew

Argyra calceata Loew, Smiths. Misc. Coll., No. 171, p. 131, 1864.

Third antennal joint about twice as long as wide, rounded at tip, the first joint with about three hairs above near the tip; hypopgium with its outer lamellae somewhat triangular, quite pointed at tip, blackish; there are two pairs of inner appendages, the outer pair the largest, broadly rounded and with two minute bristles at tip. Joints of fore tarsi as 49–17–9–7–7; those of middle tarsi as 57–31–15–9–7; hind tarsi wholly black, or nearly so, the joints as 38–43–23–14–8.

This was described from "Middle States." I have seen it from the following locations: Philadelphia, Pennsylvania; Lafayette, Indiana, July 27; Erie County, New York, July 3 to September 3; Summit County, Ohio; Auburndale, Massachusetts, August 28; Cornish, New Hampshire, July 13; Mount Ascutney, Vermont, July 11, at 2,000 feet elevation; Bar Harbor, Maine, July 19; Emsdale, Ontario, July 30.

24. ARGYRA ALBICOXA, new species

Male.—Length, 4.5 mm. Face silvery white, rather wide. Front almost wholly covered with silvery pollen. Palpi yellowish. Antennae black; first joint with numerous hairs above; third joint broad, rounded at tip, scarcely as long as the basal two taken together; arista inserted near the tip, scarcely as long as the antenna. The black orbital cilia rather strong, but only reaching down a little way on the sides; beard whitish, quite abundant.

Thorax shining green with considerable white pollen on the sides; scutellum with four large marginal bristles, without hairs on the surface; posterior margin of pleurae pale yellow. First four abdominal segments yellow with narrow black hind margins, apical segments black; the abdomen is shining, with very little white pollen, its hairs black. Hypopygium and its appendages black with extreme base of outer lamellae a very little yellowish, small, somewhat triangular.

All coxae, femora and tibiae yellow, middle coxae a little darkened on outer surface; fore coxae with silvery pollen, their anterior surface nearly bare, still there are a few minute yellow hairs at base and large black bristles at tip, which reach to their middle on outer edge. Fore femora with the black hair on the posterior surface longer than that on the remaining portions and with a row or two of minute yellow hairs below; middle femora with only short hair, a few of those on lower surface pale yellow. Hind femora and tibiae scarcely darkened at tip, the former with only short black hair. Bristles on all tibiae rather short. Fore and middle tarsi yellow, blackened towards their tips; hind tarsi wholly black; joints of fore tarsi as 51–18–10–6–6; of middle ones as 63–27–18–8–7; those of hind tarsi as 37–37–20–13–10. Calypters yellow with narrow brown tips, their cilia yellow but appearing nearly black in certain lights. Halteres pale yellow.

Wings grayish; third vein bent backward a little at tip; bend in last section of fourth vein at the length of the crossvein from that vein, fourth vein parallel with third beyond this bend; last section of fifth vein nearly twice as long as the crossvein.

Described from one male taken at Hull, Quebec, July 23, 1923, by C. H. Curran.

Type.—In Canadian National Collection.

25. ARGYRA CALCITRANS Loew

Argyra calcitrans Loew, Smiths. Misc. Coll., No. 171, p. 130, 1864.

A rather abundant eastern form with silvery face, velvety black palpi, third antennal joint only a little shorter than the face, arista

about equal to the third joint in length; legs and feet wholly yellow, middle and hind coxae a little blackened at base; middle femora with rather long brown hair on lower anterior edge; posterior femora with long black bristle-like hairs on lower edge; hind basitarsus with many long bristles; joints of fore tarsi as 36–9–8–5–6; those of middle tarsi as 32–16–12–8–8; joints of hind tarsi as 32–13–13–10–9.

This was described from New York State. I have seen specimens from Auburndale, Massachusetts, June 7; Sharon, Massachusetts, July 7; Apponaug and Buttonwoods, Rhode Island, June 21; Rowayton, Connecticut, June 15; Clementon, New Jersey, May 30; Westville, New Jersey, June 27; Erie County, New York, June 7 to July 1; Lafayette, Indiana, June 17; Dyke, Virginia, May 28; and Orillia, Ontario, July 18.

The female of this, or what I take to be the female, has the abdomen wholly green; fore coxae, femora, tibiae, and tarsi wholly yellow; middle and hind coxae yellow, more or less blackened on outer surface. The joints of the tarsi vary in length, but the second joint of hind tarsi is about two-thirds as long as the first; in the average specimens the joints of the tarsi are about as follows: Fore tarsi 29–9–8–5–5; middle trasi, 31–16–12–8–7; hind tarsi, 29–17–8–4–5. In one large specimen the joints of fore tarsi are as 40–15–10–7–7, and hind tarsi as 40–26–18–10–7.

If this is not the female of *calcitrans*, there do not seem to be any other females in my hands that would belong to that species and no male to go with these females. We have these females from Lafayette, Indiana, June and July; Wellesley, Massachusetts, July 18; Colden, New York, August 9; Portage, New York, July 1; and Orillia, Ontario, July 18.

26. ARGYRA SETIPES, new species

Male.—Length, 4–4.7 mm. Face and front silvery white, the former narrow. Palpi and proboscis black, the former with yellowish hairs. Antenna (fig. 22) black; first joint with several stout hairs above; third joint brown, three times as long as the first two taken together; arista scarcely as long as the third joint. Lateral and inferior orbital cilia whitish, the minute black upper cilia reach down one-third the eye height.

Dorsum of thorax and the scutellum dark shining green, the former with abundant silvery white pollen on the anterior two-thirds; scutellum with one pair of large marginal bristles. Abdomen covered with silvery white pollen; first segment black; second yellow with anterior and posterior margins and a connecting

median stripe, black; hind margins of three apical segments black; hind margins of second to fifth segments narrowly white; hairs of the abdomen black, a few long ones on the sides of first, second, and third segments yellow. Hypopygium (fig. 20) small, black; its outer lamellae yellow, truncate at tip, fringed with long hairs; inner appendages black, not conspicuous.

All coxae yellow, middle and hind ones more or less blackened on outer surface; the hairs and bristles of the coxae are mostly black. All femora and tibiae yellow, posterior pair brown or black at tip. Fore and middle femora with quite long, hind ones with very short yellow hairs below; fore femora with long hairs on the posterior surface, which appear black when seen from above and yellow when viewed from below; sometimes they are wholly black except the lower row; middle and hind femora with a few black bristle-like hairs near the tip on anterior surface. Fore tarsi yellow with fifth joint black, their joints as 45–17–11–7–7; those of middle tarsi as 46–17–15–9–7; hind tarsi yellow, a little darker at tip, their joints as 50–20–18–11–8, first joint with two rows of long bristles on the anterior and posterior edges of the lower surface, the longest of which are about as long as the third joint of the tarsi. Calypters and halteres yellow, the former with brown tips and long yellow cilia.

Wings grayish; third vein only slightly bent backward at tip; last section of fourth vein bent before its middle, parallel with third, ending near the apex of the wing; last section of fifth vein scarcely one and a half times as long as the crossvein.

Female.—Face not very wide, silvery white, suture near apical fourth, palpi yellow with a few black hairs near the tip. Third antennal joint nearly round, still a little pointed at tip, arista subapical. Abdomen yellow, a blackish spot at the middle of the dorsum on the first segment; a line on the hind margin of second, third, and fourth and the whole of fifth segment black. Femora, tibiae, and tarsi yellow, tips of middle and hind tarsi darker; posterior basitarsus with distinct but minute bristles below.

Described from 23 males and 3 females. Three males were taken at Colden, Erie County, New York, August 5 and 23; one at Hamburg, Erie County, New York, July 9; one at Delaware Water Gap, New Jersey, July 11; one at Brattleboro, Vermont, July 15; and one at Chester, Massachusetts, July 25; two females were taken at Little Valley, New York, July 4 and 18; and one female at Colden, Erie County, New York, July 23. Sixteen males were taken by C. H. Curran at Orillia, Ontario, July 13–18, 1923.

Type.—Male, Cat. No. 27048, U.S.N.M., from Colden, New York.

27. ARGYRA ALDRICHI Johnson

Argyra aldrichi Johnson, Psyche, vol. 10, p. 18, 1904; also a note in Psyche, vol. 13, p. 60.

Male.—Length, 4.5 mm. Face and front silvery white, the former moderately wide. Palpi and proboscis yellow. Antennae black; first joint conspicuously bristly above; third joint only slightly longer than the basal two taken together; arista apical, about as long as third joint. Lateral and inferior orbital cilia white, the small black upper cilia white; the small black upper cilia reach down only to the upper fourth of the eye height.

Dorsum of thorax dark shining green, without white pollen, except on the humeral angles, which are thickly covered with the silvery white pollen; scutellum with two pairs of marginal bristles. First three abdominal segments yellow, first widely black in the center above, second and third narrowly black on hind margin; fourth segment with a little more than basal half yellow, remainder of fourth and the whole of fifth and sixth black; all segments with extreme apical margin white; the hairs on the abdomen small and black; still they appear yellowish in certain lights, long bristles on upper portion of first segment black, but there are long yellow hairs on the lower part of the sides. Hypopygium (fig. 19) with upper part testaceous, lower portion shining black, it is constricted in the middle, the apical part being nearly globular; its outer lamellae long, curved, brown, fringed with hairs.

All coxae, posterior margin of pleurae, femora, and tibiae wholly yellow. Bristles of coxae black. Fore and middle femora with short yellow hairs below. Fore tarsi mostly yellow, lower edge of second joint a little hollowed out and with a bunch of short spines at base: joints of fore tarsi as 50–17–14–15–12; joints of middle tarsi as 58–30–20–13–10; hind tarsi wholly black, their joints as 40–43–29–17–10. Calypters, their cilia and the halteres pale yellow.

Wings gray; last section of fourth vein bent near its middle; it is nearly parallel with third and ends just back of the apex of the wing; last section of fifth vein not quite twice as long as the cross-vein.

Female.—Face about twice as wide as in the male; palpi large, yellow; third antennal joint not quite as long as the basal two together. Thorax, coxae, legs, and feet colored as in the male; abdomen yellow with narrow black margins on the first four segments, fifth wholly black. Wings as in the male.

Redescribed from two males and one female taken by C. W. Johnson, the males were taken at Buttonwoods, Rhode Island, June, 1912: the female at Bristol, Rhode Island, June 21, 1918. The type

locality is Goose Neck, New Jersey. C. W. Johnson reports it from New Haven, Connecticut, June 8. One male from Buttonwoods, Rhode Island, is deposited in the United States National Museum.

28. ARGYRA MINUTA Loew

Argyra minuta LOEW, Smiths. Misc. Coll., No. 171, p. 129, 1864.

A small species with the legs and feet wholly yellow, palpi and antennae black. The outer hypopygial lamellae are narrow, rather short, yellowish; inner appendages somewhat conical with a bristle at apical point. The male has the joints of fore tarsi as 33–12–8–5–5, their tibiae as 54; the joints of hind tarsi are as 30–24–15–8–6. The female has the joints of fore tarsi as 22–13–9–6–6; those of hind tarsi as 28–22–18–9–8.

It is difficult to separate the female of this from that of *calcitrans* Loew and *setipes* new species. I give below the length of the joints of fore and hind tarsi of the females of the last two named species as I separate them, for comparison with those of *minuta*.

The joints of fore tarsi of the female of *calcitrans* are as 33–14–9–6–7, those on hind tarsi as 32–25–18–17–16. The joints of the fore tarsi of *setipes* are as 42–19–15–9–7, those of hind tarsi as 35–35–23–15–9. The palpi in *setipes* are yellow and large; while in both the other species the palpi are smaller and blackish.

29. ARGYRA FLAVIPES, new species

Male.—Length, 3 mm. Face and front silvery white. Palpi covered with silvery pollen. Proboscis yellowish. Antennae (fig. 15) black; I can see but one hair on the upper edge of first joint; third joint more brown, longer than the basal two taken together, rounded at tip; arista inserted a little beyond its middle.

Dorsum of thorax shining green with but little silvery white pollen: pleurae more black with its posterior edge yellow. First abdominal segment black; second, third, and fourth yellow, their posterior margins rather widely black; fifth and sixth black with green reflections. Hypopygium (fig. 18) black; its appendages yellowish; outer lamellae somewhat triangular, fringed with long hairs; inner appendages a little clavate.

All coxae, femora, tibiae and tarsi wholly yellow, tips of tarsi only a little darker and sometimes the tips of hind femora are brownish; middle femora with one preapical bristle, nearly bare below; posterior pair with a row of slender bristles on anterior surface, several of which are longer than the width of the femora. Fore tarsi with their joints as 28–15–9–7–10; joints of hind tarsi as 29–20–15–10–6. Calypters, their cilia and the halteres yellow.

Wings grayish; third vein straight; fourth vein nearly straight; parallel with third; last section of fifth vein twice as long as the crossvein.

Female.—Face wider; palpi yellow, blackened on basal half; first antennal joint with several hairs above; first abdominal segment yellow, otherwise the abdomen as in the male; pleurae, coxae, legs, feet and wings about as in the male.

Described from one pair taken near Plummer Island, Maryland, the male on May 21 and the female on June 2; nine males and three females taken by Dr. J. M. Aldrich, at Lafayette, Indiana, June 9 to July 19; and one female taken by him at Turkey Run, Indiana, August 20.

Paratypes.—Both sexes, 12, Cat. No. 27049, U.S.N.M.

30. ARGYRA FLAVICORNIS, new species

Male.—Length, 3 mm. Face rather narrow, silvery white. Front covered with white pollen, still the green ground color shows through. Palpi and proboscis reddish-yellow. Antennae (fig. 25) yellow; first joint with three or more hairs above and a few minute ones below near the tip; third joint narrowly black above, longer than the basal two taken together, rounded at tip; arista black, scarcely as long as the antenna, inserted near apical third of third joint. Lower orbital cilia short and sparse, yellowish.

Dorsum of thorax and the scutellum dark shining green, with a little pollen along the front; the scutellum with one pair of widely separated marginal bristles. First four segments of the abdomen yellow with their hind margins black; apical segments black with green reflections, still the fifth is narrowly yellow on its sides at base; hairs of the abdomen yellow, a few of the bristles on the sides of the hind margin of first segment are black. Hypopygium (fig. 26) more testaceous than black, its appendages yellow; the outer lamellae broad, somewhat triangular in outline, yellow with black dots at the root of the hairs on its disk; inner appendages are a pair of large clavate organs and a pair of slender shorter ones, the central filament is conspicuous in the type specimens.

Coxae, legs and feet wholly yellow, coxae with only short yellow hair and no bristles, except one erect black one on hind coxae and several very small black ones near the tip of fore coxae; femora and tibiae with very short black hair. Joints of fore tarsi as 37–10–8–5–7. Joints of posterior tarsi are as 30–28–17–11–8. Calypters yellow with a small brown spot at tip and black cilia. Halteres yellow.

Wings slightly grayish; veins yellow; third vein bent backward at tip; last section of fourth vein only a little bent before its middle,

parallel with third at tip; last section of fifth vein one and a half times as long as the crossvein.

Female.—Differs from the male only in having the face wide; third antennal joint small, about as long as wide and the cilia of the calypters are yellow, not black as in the male.

Described from three males and four females (including type and allotype) taken by Dr. J. M. Aldrich at Lawrence, Kansas; eight males and three females taken by C. F. Adams at Atherton, Missouri, in May and June; and one male and two females taken by G. R. Pilate at Opelousas, Louisiana, in May.

This species is remarkable for its yellow antennae, the third joint of which has a black line above, and the yellow lamellae with black dots on their surface where hairs are inserted.

Type, allotype, and 6 paratypes.—Male and female, Cat. No. 27050, U.S.N.M., from Kansas and Louisiana.

31. ARGYRA OBSCURA, new species

Male.—Length, 4.7 mm. Face rather wide, with silvery white pollen; still it appears black and a little shining when seen from in front. Palpi and proboscis black with black hair. Front greenish black with white pollen, which is thick near the antennae. Antennae black, first joint with conspicuous hairs above; third joint about as long as the basal two taken together, arista apical, equal to the antenna in length. The small black orbital cilia reaching down nearly to the middle of the eye; below these there is a quite abundant white beard.

Dorsum of thorax and the scutellum blue-green, the former with considerable white pollen, which is thick on the humeri and along the sides to the root of the wings; humeri with several small bristles; there are four black bristles above the fore coxae; scutellum with four marginal bristles, and many black hairs on its disk. Abdomen dark green, all its hairs and bristles black; it has rather dense white pollen on the base of the segments; second segment with a rather large but obscure yellow spot at base on each side; there is also a small indistinct yellowish spot on each side of third segment at base. Hypopygium black, its tip and the large sheath or inner appendage testaceous; outer lamellae black with pale hairs and black bristles.

Coxae wholly black; trochanters yellowish; fore and middle coxae with long, bristly, black hairs; hind coxae with two bristles and several hairs on outer surface. Fore and middle femora black with narrow yellow tips; hind femora with basal two-thirds yellow, apical third black; fore femora with black hair on posterior surface, which is scarcely as long as their thickness; middle femora with a

row of stiff black hairs on lower anterior edge, which are not as long as their width. All tibiae pale yellow, posterior pair with nearly apical fourth black. Fore and middle tarsi yellow at base, black from the tip of the first joint; joints of anterior pair as 57–23–17–9–10; joints of middle tarsi as 62–23–17–9–6; those of hind ones as 40–35–26–14–13. Calypters pale yellow with broad black tips and yellow cilia. Halteres yellow.

Wings slightly tinged with yellowish-brown; third vein bent backward at tip; last section of fourth vein bent before its middle, parallel with third toward the tip; last section of fifth vein one and a third times as long as the cross vein.

Described from two males, taken at Mount Washington, New Hampshire, July 24, by C. W. Johnson.

Holotype.—In the author's collection.

32. ARGYRA (LEUCOSTOLA) CINGULATA Loew

Leucostola cingulata Loew, Neue Beitr., vol. 8, 1861, p. 53; Smiths. Misc. Colls., No. 171, p. 157, 1864.

Described from the District of Columbia. I have taken it in Erie County, New York, June 16 and July 4. Nathan Banks took it at Falls Church, Virginia, May 24 and July 19. Dr. J. M. Aldrich took it at Lawrence, Kansas, and Lafayette, Indiana, June 5 and July 13; and in his collection I found it from Opelousas, Louisiana, taken by G. R. Pilate in May (fig. 28).

33. ARGYRA (LEUCOSTOLA) JOHNSONI, new species

Male.—Length, 4.5 mm. Face and front silvery white, the former very narrow. Palpi yellow with silvery pollen. Proboscis brown. Antennae black; first joint short, bare above; third joint longer than the two basal joints taken together, obtuse at tip; arista inserted a little above the tip, a little longer than the antenna. Lower orbital cilia yellow, these scarcely reach to the middle of the eye, and I can not see any black cilia above them.

Dorsum of thorax dark but bright green, dulled a little with silvery white pollen, especially in front and on the lateral sides; pleurae more black with white pollen. Abdomen thickly covered with silvery white pollen, its hairs black, those of the sides being yellow; first segment mostly black; second and third yellow with very narrow hind margin of second and anterior and posterior margins of third brown; fourth black, still showing a slight yellowish color, especially on the sides; apical segments black, the extreme apical edges of all segments appear white. Hypopygium (fig. 29) black; its appendages yellow; they consist of a pair of lamellae fringed with long hairs, a

small hairy protuberance, a pair of horn-like and a pair of inner narrow lamellae-like appendages, which have a few hairs on their edges.

All coxae and their hairs and bristles yellow. All femora, tibiae, and tarsi yellow. All femora with rather long, delicate, yellow hair on lower posterior edge. Middle tibiae with three, hind ones with several, small, black bristles; the hairs of the legs appear black in certain lights, while in other lights they appear largely yellow. The comparative length of the legs and feet are as follows: Fore femora 45, tibiae 60, tarsi as 44–14–8–6–6; middle femora 80, tibiae 90, tarsi as 52–28–16–10–8; hind femora 67, tibiae 100, tarsi as 36–29–22–13–8. First and second joints of hind tarsi fringed below with stiff little hairs of nearly equal length. Calypters pale yellow with a brown margin and pale yellow cilia. Halteres dark yellow.

Wings slightly tinged with brown in front of fourth vein; last section of fourth vein a little bent at its middle, parallel with third at tip; last section of fifth vein twice as long as the crossvein.

Described from one male (type) taken at Shark River, New Jersey, July 12, 1897, by C. W. Johnson; two males from Philadelphia and one from Montgomery County, Pennsylvania. Type in the collection of C. W. Johnson.

Paratypes.—Male, Cat. No. 27051, U.S.N.M.

This differs from *cingulata* Loew in the comparative lengths of the tarsal joints, especially those of hind tarsi. The joints of the tarsi of *cingulata* are as follows: Fore tarsi, 42–15–11–6–6; middle tarsi, 47–20–15–7–7; those of hind tarsi, 26–33–20–12–7. The appendages of the hypopygium also differ somewhat.

34. ARGYRA (LEUCOSTOLA) INVOLUTA, new species

Male.—Length, 3.5–4 mm. Face rather wide for a male, silvery white. Palpi yellow with silvery pollen and several hairs and one bristle at tip, which last appears pale against a dark background and is almost as long as the palpus. Front dark green, dulled with white pollen. Antennae black; first joint bare above; third joint about as long as the basal two taken together, subtriangular; arista nearly apical, as long as the antenna.

Dorsum of thorax bright green, shining, with a little white pollen in front; pleurae more blackish. Abdomen shining green with some coppery reflections; second segment with a large yellow spot on each side, these spots only leave a median stripe, widening posteriorly, and a narrow hind margin, which is green. Hypopygium (fig. 31) small, greenish-black; the outer lamellae of nearly equal width throughout and oblique at tip, fringed with pale hairs; there appear

to be three pairs of inner appendages which are yellowish-brown and a central filament extending back about as far as the lamellae.

Coxae yellow with all their hairs and bristles yellow; middle and hind pairs a little brownish on outer surface. Femora yellow: fore and middle pairs with yellow hairs below; posterior pair brown above for nearly one-third their length and with several black hairs near the tip on lower outer edge. Fore and middle tibiae yellow: hind tibiae blackish, except extreme base; middle tibiae without a bristle below. Fore and middle tarsi yellow, darkened at their tips, the former as long as their tibiae, their joints as 28–10–8–5–6; hind tarsi wholly black, their joints as 24–22–20–7–7. Calypters yellow with extreme tip brown, their cilia yellow. Halteres yellow.

Wings grayish; last section of fourth vein a little bent at its middle, parallel with third at tip; crossvein distinctly oblique, not at right angles with fourth vein; last section of fifth vein a little longer than the first section, nearly straight, one and a half times as long as the crossvein; anal angle of wing prominent.

Described from two males taken by Dr. J. M. Aldrich; the type was taken at Lafayette, Indiana, June, 1908; the other was taken at Erwin, South Dakota, June 2. Both specimens are in the United States National Museum.

Type.—Male, Cat. No. 27052, U.S.N.M.

35. ARGYRA (LEUCOSTOLA) FLAVICOXA, new species

Male.—Length, 5 mm. Face and front silvery white, the former moderately narrow. Occiput green with thin white pollen. Palpi yellow with silvery white pollen and a black bristle at tip. Antennae black; first joint bare above; second not as long as wide; third joint slightly longer than the basal two taken together, obtuse at tip; arista subapical, slightly longer than the antenna. Lower orbital cilia yellowish white and short, the very short, black, upper cilia reach down to the middle of the eye height.

Dorsum of thorax bright green with bronze reflections and abundant silvery white pollen; scutellum with one pair of large marginal bristles. Abdomen black, but so thickly covered with silvery pollen as to conceal the ground color when viewed from in front; second segment pale yellow, except a broad median stripe which expands along the hind margin of the segment; third and fourth segments each with a large yellow spot on either side, which reach the posterior edge, but leave a black basal margin on each side; venter yellow with the last segment brown. Hairs of the abdomen black, except those on the yellow portion of second segment and on the venter, which are yellow. Hypopygium (fig. 27) black, the small apical portion and the appendages yellow, these consist of a pair of outer lamellae

which are fringed with yellow hairs, a pair of curved hornlike organs and a pair of flattened appendages, which are obliquely truncate at tip, ending in a small bristle.

All coxae, femora, fore and middle tibiae pale yellow; hairs of fore coxae yellow, one or two of their bristles black; hairs and bristles of middle and hind coxae black. Hind femora slightly darkened at tip and with the lower hairs on outer side near the tip longer. Fore and middle femora fringed on lower surface with delicate yellow hairs, which are scarcely as long as the width of the femora, the middle pair with one small preapical bristle and about five delicate black hairs on posterior side at tip; bristles of the tibiae small. Hind tibiae brownish-yellow, not darker at tip. Fore and middle tarsi yellow, darker apically; joints of fore tarsi are as 47–18–10–6–6; those of middle tarsi as 58–22–18–10–9. Hind tarsi wholly black with the first and second joints as 37–33. Calypters and halteres pale yellow, the former with a black tip and long pale cilia.

Wings grayish, tinged with yellowish-brown; third vein slightly bent backward at tip; last section of fourth vein a little bent just before its middle, parallel with third at tip; last section of fifth vein scarcely twice as long as the crossvein.

Described from one male taken by C. W. Johnson, at Daytona, Florida, April 8, 1917. Type in the collection of C. W. Johnson.

36. ARGYRA (LEUCOSTOLA) INAEQUALIS, new species

Male.—Length, 3 mm. Face narrow, silvery white. Palpi yellow with white pollen. Front nearly opaque with white pollen. Antennae black; first joint bare above; third joint longer than the basal two taken together, sometimes twice as long as wide, obtuse at tip; arista inserted above the point, scarcely as long as the antenna. Lower orbital cilia white, inconspicuous.

Dorsum of thorax shining green with white pollen on the anterior portion; scutellum with one pair of large marginal bristles: pleurae dull green with white pollen. Abdomen shining green, venter, posterior edge of first segment at the sides, all of second segment, except a median stripe, which is widened at anterior and posterior margins, and a spot on each side of third segment, yellow; hairs on the green portion black, those on the yellow part mostly yellowish. Hypopygium (fig. 30) black or greenish; its appendages mostly yellowish; outer lamellae elongate, triangular, with delicate hairs on the edges and one long one at tip.

All coxae and their hairs and bristles yellow, middle and hind pairs a little infuscated at base on outer surface. All femora and tibiae together with their hairs, yellow; tips of posterior femora brown above; all femora with delicate yellow hairs below, which

are scarcely longer than those on the upper edge, the middle and hind pairs also have a few black bristle-like hairs near the tip on lower anterior edge; the black bristles on middle and hind tibiae very small. Fore and middle tarsi yellow, a little darker at tip; the joints of fore tarsi as 27–10–6–4–6. Hind tarsi (fig. 34) black from the tip of the first joint, their joints as 23–17–12–8–6, the first joint slightly enlarged at tip and with a projection which bears a cluster of hairs, these usually form a thorn-like tip to the joint, but sometimes they are a little more separated. Calypters and halteres pale yellow, the former with white cilia.

Wings slightly grayish, veins brown; last section of fourth vein a little bent at its basal third, nearly parallel with third beyond this bend, ending in the apex of the wing; last section of fifth vein twice as long as the crossvein.

Described from five males taken by Dr. J. M. Aldrich at Lafayette, Indiana, June 9 to July 31.

Type.—Male, Cat. No. 27053, U.S.N.M.

There is quite a variation in the length of the third antennal joint, the extent of the brown at tip of hind femora, the yellow of hind tarsi and in the color of the hairs on the legs, still I think there can be no doubt of their all being one species.

37. ARGYRA (LEUCOSTOLA) SPINA, new species

Male.—Length, 3.5 mm. Face narrow, silvery white. Palpi yellow with white pollen and one black hair at tip. Front opaque with white pollen. Antennae black; first joint bare above; third joint a little longer than the two basal ones taken together, but little longer than wide, rounded at tip; arista a little longer than the antenna, inserted a little before the tip of the third antennal joint. Lower orbital cilia white and rather short.

Thorax shining green with white pollen on anterior portion, especially at the sides; scutellum with one pair of large marginal bristles. Abdomen with the first segment green with black bristles on the hind margin and a few yellow hairs on the lower edge at the sides; second segment yellow with a median green stripe, which widens at fore and hind margins, it has long yellow hairs on the lower edge of the sides; third segment black with a large yellow spot on each side; fourth, fifth, and sixth segments black; last four segments thickly covered with silvery white pollen. Hypopygium (fig. 32) black, its appendages yellow; outer lamellae short, triangular, with delicate hairs above and a long one at tip; there are two pairs of inner appendages.

Coxae yellow, with yellow hairs, their bristles black in certain lights, viewed in other lights they are yellow. Femora and tibiae

yellow. All femora with a row of yellow hairs below which are a little longer than those above; hind pair black at tip above and with a few slender black bristles on apical third of outer surface, which are about as long as width of the femora. Middle tibiae with rather long bristles above. All tarsi almost wholly yellow; fore and middle tarsi longer than their tibiae; joints of the anterior tarsi as 30–12–6–5–6. Hind tarsi (fig. 33) with their joints as 24–23–16–9–7, their first joint with a thornlike projection at tip; fifth joint contracted in the middle. Calypters yellow with a narrow black tip and white cilia. Halteres yellow.

Wings a little grayish; last section of fourth vein a little bent just before its middle, parallel with third beyond this bend, ending in the apex of the wing; all veins rather widely separated, as the wing seems wide; last section of fifth vein one and a half times as long as the crossvein.

Described from one male taken by Doctor Aldrich at Lafayette, Indiana, July 25.

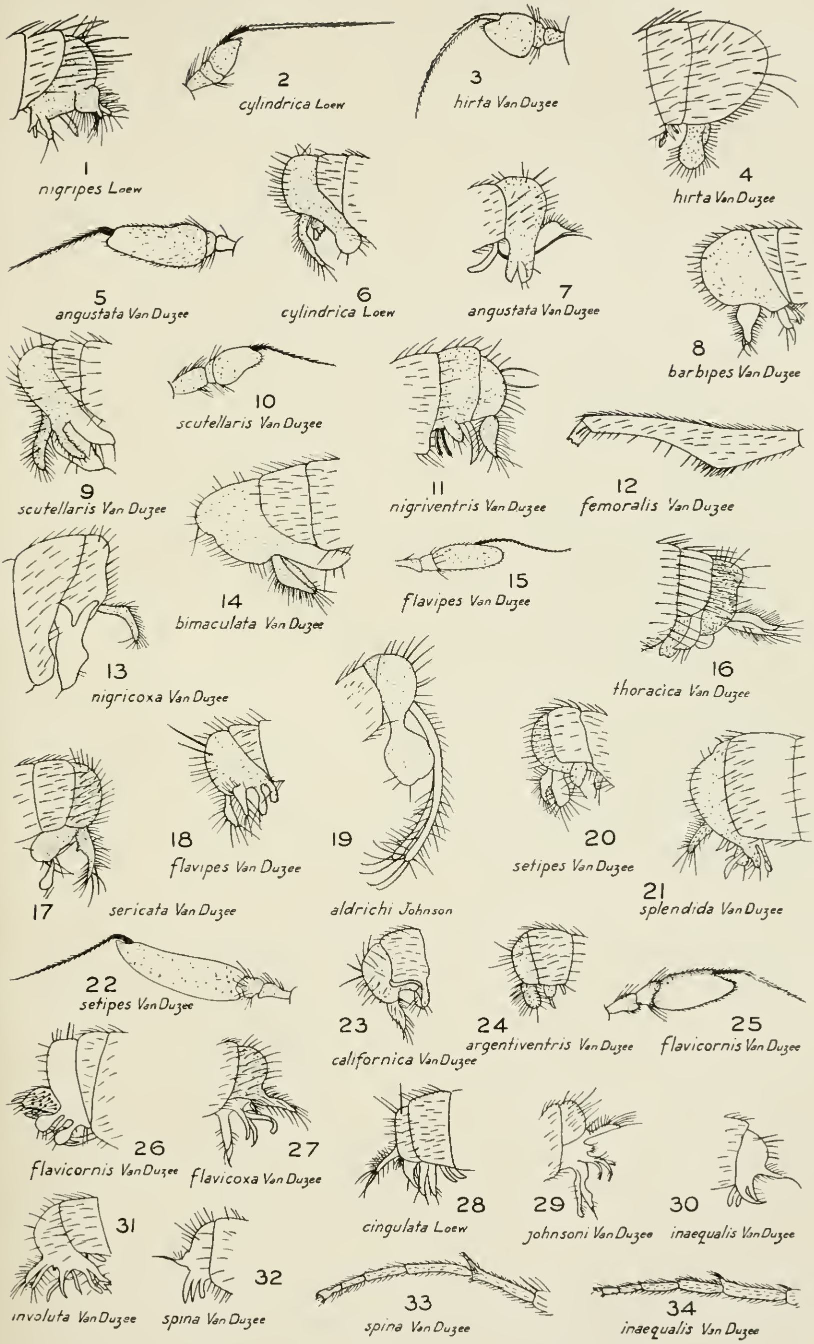
Type.—Male, Cat. No. 27054, U.S.N.M.

This is very much like the preceding species; it differs in the proportionate lengths of the first and second joints of hind tarsi: length of the arista, length of the bristles on the middle tibiae, length of the outer hypopygial lamellae and in other minor points.

EXPLANATION OF PLATE

(Drawings by the author)

FIG. 1. *Argyra nigripes* Loew. Hypopygium of male.
2. *cylindrica* Loew. Antenna.
3. *hirta*, new species. Antenna of male.
4. *hirta*, new species. Hypopygium.
5. *angustata*, new species. Antenna of male.
6. *cylindrica* Loew. Hypopygium.
7. *angustata*, new species. Hypopygium.
8. *barbipes*, new species. Hypopygium.
9. *scutellaris*, new species. Hypopygium.
10. *scutellaris*, new species. Antenna of male.
11. *nigriventris*, new species. Hypopygium.
12. *femoralis*, new species. Middle femur of male.
13. *nigricoxa*, new species. Hypopygium.
14. *bimaculata*, new species. Hypopygium.
15. *flavipes*, new species. Antenna of male.
16. *thoracica*, new species. Hypopygium.
17. *sericata*, new species. Hypopygium.
18. *flavipes*, new species. Hypopygium.
19. *aldrichi* Johnson. Hypopygium.
20. *setipes*, new species. Hypopygium.
21. *splendida*, new species. Hypopygium.
22. *setipes*, new species. Antenna of male.
23. *californica*, new species. Hypopygium.
24. *argentiventris*, new species. Hypopygium.
25. *flavicornis*, new species. Antenna of male.
26. *flavicornis*, new species. Hypopygium.
27. *flavicoxa*, new species. Hypopygium.
28. *cingulata* Loew. Hypopygium.
29. *johnsoni*, new species. Hypopygium.
30. *inaequalis*, new species. Hypopygium.
31. *involuta*, new species. Hypopygium.
32. *spina*, new species. Hypopygium.
33. *spina*, new species. Hind tarsus of male.
34. *inaequalis*, new species. Hind tarsus of male.



North American Species of the Genus Argyra

For explanation of plate see page 43

A NEW PROLIFERATING LARVAL TAPEWORM FROM A PORCUPINE

By Benjamin Schwartz

Of the Zoological Division, Bureau of Animal Industry, U. S. Department of Agriculture

Under date of January 13, 1924, A. H. Twitchell, of Takotna, Alaska, a correspondent of the Bureau of Biological Survey, forwarded to that bureau from Ophir, Alaska, a portion of lung from a porcupine containing tapeworm cysts, with the following comments:

I am sending you by parcel post one box containing a piece of lung of a porcupine with what we believe to be cysts of a tapeworm. It is preserved in salt brine. Collected by C. A. Fowler; data with specimen. We have many of these porcupines on the range and I have suspected that they may be the source from which our deer get some of their parasites. I did not see this one, but only took the bottled specimen and shipped it. Tapeworms and other worms are often found in great numbers in porcupines. I have never seen a porcupine in this condition.

The question of the probable specific identity of the host was referred to Dr. Hartley H. Jackson, of the Biological Survey, who replied as follows:

The porcupine of that region is probably *Erethizon epixanthum myops* Merriam. At least you may be sure of the species *Erethizon epixanthum* Brandt.

Examination of the material forwarded by Mr. Twitchell showed two detached cysticerci and a number of cysticerci attached to the lung tissue, some being attached directly to the lung by means of a peduncle that penetrates into the lung tissue and others being attached indirectly, the peduncles of the individual cysticerci converging to a more or less common origin from which a stalk penetrates into the lung substance. Aside from the fact that the species has been heretofore undescribed it is of particular interest in view of the fact that it is a proliferating larval cestode, belonging to the genus *Taenia* in which group multiplication of larval forms by means of budding is comparatively rare.

TAENIA TWITCHELLI, new species, 1924

Strobilate tapeworm unknown. Cysticerci from 0.7 cm. long by 0.4 cm. wide to 2 cm. long by 0.6 cm. wide, occurring singly and in

colonies, the latter branching in typical dendritic fashion. The cysticerci enter into the lung tissue by basal stalks or peduncles, which in the case of single cysticerci penetrate directly into the lung substance, and in the case of colonial cysticerci, are connected to larger stalks which ultimately penetrate into the lung. Head invaginated, 0.9 mm. wide in press preparation, armed with a double row of hooks, consisting of 18 large hooks and 18 small hooks (fig. 1). The large hooks (fig. 2*a*) are from 189μ to 198μ long. They have a blade of marked curvature, a handle which is long and thick and which is only slightly sinuous in outline on its dorsal surface, the ventral surface being smooth. The dorsal surface of the handle forms a continuous line with that of the blade. The surfaces of the handle are almost parallel, the posterior end of that structure being bluntly rounded. The guard is strikingly long, bifid, and conical in shape, its maximum diameter being in the region of its union with the blade and handle. The small hooks (fig. 2*b*) are from 155μ to 163μ long. They have a strongly curved blade whose dorsal margin forms a continuous line with that of the handle. The latter has parallel margins and a rounded posterior end. The guard is bifid and has a bluntly rounded end. The suckers are elliptical in shape and have a maximum diameter of 165μ to 185μ.

Host.—*Erethizon epixanthum.*

Location.—Lung.

Locality.—Ophir, Alaska.

Type specimen.—United States National Museum Helminthological Collections, No. 26003.

The mode of branching is shown in figure 3. Two of the cysticerci are attached directly to the lung tissue (*b*), and so far as can be seen, have no connection with the remaining cysticerci which form a branching colony. The latter is connected by a stalk (*z*) that emerges from the lung substance and divides into two main branches, one branch (*x*) bearing a developed cysticercus and two small buds (*c*) growing out in the region of the base of the cysticercus. The second branch (*y*) bears several developed cysticerci and several small buds. The cysticerci converge to a more or less common origin, each cysticercus being connected to the main branch by means of a peduncle, with a single exception (*a*) in which two cysticerci are connected by a single peduncle the two bladders being joined about half way above their point of origin. The two isolated cysticerci (*b*) occur singly without buds or branches.

Multiplication of larval cestodes by means of budding is known to occur in *Sparganum*, in cysticercoids and in coenuri, is the rule in Echinoccus, and has been noted in cysticerci. A variety of *Cysticercus cellulosae* that exhibits the phenomenon of proliferation is fre-

quently referred to as *Cysticercus racemosus*, this form having been found in the human brain several times. Braun (1897) cites two additional cysticerci that exhibit the phenomenon of larval multiplication by budding, namely, *Cysticercus botryoides* and *Cysticercus longicollis*. With regard to the former which has been found only once by Boettcher in 1862 in the back muscles of a rabbit, there exists a divergence of opinion among helminthologists concerning its zoological status, certain writers taking the view that it is a coenurus. Braun (1897) is convinced, however, that it is a cysticercus allied to *Cysticercus longicollis*, the intermediate stage of *Taenia crassiceps* of the fox. Railliet (1895) regards *Cysticercus botryoides* as well as *Cysticercus racemosus* as a synonym of *Cysticercus cellulosae*. According to Braun (1897) the buds given off from the parent bladder of *Cysticercus longicollis* become detached, whereas in *Cysticercus botryoides* they remain in permanent union until they reach the definite host, which when its life history becomes known will probably be found to be true of the cestode discussed in this paper (*Taenia twitchelli*), so far as can be judged from appearances which indicate a permanent union of the cysticerci in the branching colony.

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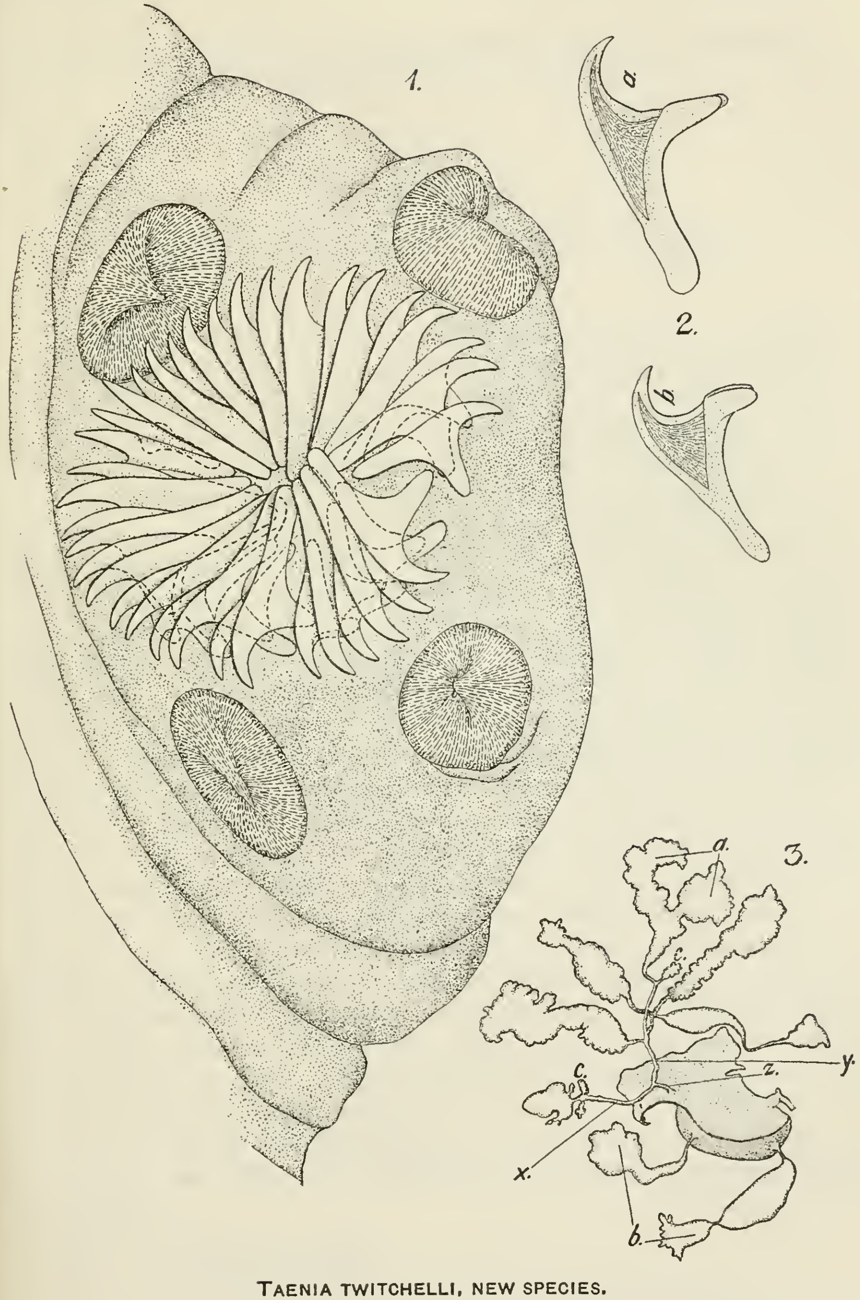
EXPLANATION OF PLATE

Fig. 1. Enlarged drawing of head of *Taenia twitchelli* showing suckers and hooks. (Press preparation.)

2. Large hooks (*a*) and small hooks (*b*) (enlarged).

3. Showing the mode of branching of *Taenia twitchelli.* The stalk (*z*) embedded in the lung tissue bifurcates into two branches, one of which (*x*) bears a developed cysticercus and two buds (*c*), and the other (*y*) gives off a number of cysticerci. Two cysticerci (*a*) have a common peduncle by which they are attached to the main branch and an immature bud (*c*) at the base. Two cysticerci (*b*) each originate independently from the lung tissue and are not connected to each other or to the colony of cysticerci (enlarged).

4



TAENIA TWITCHELLI, NEW SPECIES.

FOR EXPLANATION OF PLATE SEE PAGE 4.

CHINESE AMPHIBIANS AND REPTILES IN THE UNITED STATES NATIONAL MUSEUM

By Leonhard Stejneger

Head Curator of Biology, United States National Museum

The United States National Museum has of late years received a large number of amphibians and reptiles from China, and as there are indications of an increasing interest in these vertebrates among students and collectors in that country, it has been thought best to give as full an account as practicable of the material available, in order to acquaint them not only with what the National Museum possesses, but inferentially with what is still needed before a complete herpetology of China proper can be attempted. In my Herpetology of Japan and Adjacent Territory [1] I included not only the Russian Coast Province of Siberia, but also Korea, eastern Manchuria, and adjoining parts of northeastern China proper. Each genus and species, the Chinese ones included, were treated in detail, with full synonymy and bibliographic references, etc. In a subsequent paper, The Batrachians and Reptiles of Formosa,[2] genera and species added to the fauna since 1907 were similarly elaborated in full. It has been considered unnecessary to repeat these synonymies and references in the present paper, hence only genera and species not found in the two earlier works are here treated in the same manner. However, reference has been given under each species to the page in the Herpetology of Japan and the paper relating to Formosa, where the species with synonymy, description, and frequently also illustration may be found. In addition, references omitted in the earlier work are given in so far as they relate to China proper, but no attempt has been made to include those referring to Hainan and Formosa.

The paper by R. Mell, Beitraege zur Fauna sinica (Arch. Naturg., vol. 88, sect. A, 1922) was received too late to be incorporated in the synonymies.

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[1] Bull. U. S. Nat. Mus. No. 58, 1907.

[2] Proc. U. S. Nat. Mus., vol. 38, May 3, 1910, pp. 91–114.

The National Museum is particularly anxious to receive additional material of the critical species discussed in detail in the following pages, as well as species not yet represented in our collection.

The orthography of the Chinese locality names and their identification in the various publications of French, German, English, and Russian writers, who have each used a transliteration into his own particular language, has caused great trouble. The confusion has been increased by some Russian herpetologists who have retransliterated from the Russian alphabet to the German or the Polish. However, the necessity of a uniform spelling of these names in the following paper is obvious. On the other hand, it is equally obvious that some authority had to be followed, which has been generally adopted and whose names are incorporated in detailed maps where they may be easily located. As such an authority I have selected the Atlas of the Chinese Empire, specially prepared by Edward Stanford for the China Inland Mission, 1908. This Atlas consists of separate maps of the 18 provinces of China proper on the scale of 1:3,000,000, and 4 of the great dependencies Sinkiang, Manchuria, Tibet, and Mongolia, on the scale of 1:7,500,000, together with an index to all the names on the maps.

With regard to the system of orthography followed in this Atlas, the Editorial Secretary of the Mission writes in the preface:

> After carefully considering the relative values of the various systems in use, it was felt that the orthography adopted by the Chinese Imperial Post Office must ultimately carry the day, since conformity to that spelling would be necessary in all postal and telegraphic communications with China, a usage which could hardly fail to be a determining factor of no small importance.
>
> It is probable that the romanisation adopted will not satisfy all sinologues, but academic considerations have frequently to yield to a practical *modus operandi.*

Whenever practicable, except in quotations, I have therefore adopted the spelling of this Atlas. In some cases alternate spellings have been given. In cases where I have been unable to find a locality on any of the maps accessible to me I have had to fall back on the spelling of the specimen label or the publication referring to that particular locality. I regret very much that in many instances it has been impossible to locate names given by Abbé Armand David, the French missionary, on the Atlas to which I have referred. Some of them could be located on the maps accompanying his Journal de mon Troisième Voyage d'Exploration dans l'Empire Chinois (2 vols., Paris, 1875), in which case his spelling of the names has been accepted.

Class AMPHIBIA

Order CAUDATA

Family CRYPTOBRANCHIDAE

MEGALOBATRACHUS JAPONICUS Temminck

Synonymy, Herpetology of Japan, 1907, p. 6, to which add:

Megalobatrachus maximus BOULENGER, Cat. Batr. Grad. Brit. Mus., 1882, p. 80 (Japan, China).—BOETTGER, Offenbach. Ver. Naturk., 24–25 Ber., 1885, p. 166 (Mupin).—GUENTHER, in Pratt's To Snows of Tibet, 1892, p. 243 (Kia-ting-fu, Szechwan, 1,070 feet altitude).—WERNER. Abh. Bayer, Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p. 371.—WOLTERSTORFF, Abh. Mus. Magdeburg, vol. 1, 1906, p. 132 (Canton, probably from interior).—VOGT, Sitz. Ber. Ges. Naturf. Freunde, Berlin, 1914, p. 102 (northern Kwangsi).—DUNN, Bull. Mus. Comp. Zoöl., vol. 62, 1918, p. 134 (Japan; Szechwan).

Cryptobranchus maximus STANLEY, Journ. N. China Asiat. Soc., vol. 46, 1915, p. xiv (Yachow, Szechwan).

Megalobatrachus japonicus BARBOUR, Mem. Mus. Comp. Zoöl., vol. 40, no. 4, 1912, p. 125 (Yachow and Hung-ya-hsien, Szechwan).

Megalobatrachus species DESPAX, Bull. Soc. Zool. France, vol. 38, 1913, p. 134 (Prov. Kweichow; Shensi); Bull. Mus. Hist. Nat., Paris, vol. 19, 1913, p. 183 (Kweichow).

While the material at hand can not be considered as conclusive, consisting as it does of only two Chinese specimens, one adult and one young, and eight Japanese specimens, adult and young, nevertheless I have come to the conclusion that Boulenger and Barbour may be correct in considering *Sieboldia davidiana*[3] as a synonym of *M. japonicus.* It should be noted, however, that in our large Chinese specimen the tubercles on top of the head are smaller and leave a wider smooth space between the eyes. The tubercles also have a tendency to go in pairs. In all our five large Japanese specimens the top of the head is much rougher with much larger and more numerous tubercles. The Chinese example also has slightly larger fingers and toes, and the nostrils appear to be a trifle farther apart.

Both of our Chinese specimens are from Yachow, Szechwan. The adult one (No. 52409) we owe to the kindness of E. F. Shields, and the young (No. 65454) to L. A. Lovegren.

Family SALAMANDRIDAE

TRITURUS[4] ORIENTALIS (David)

1875. *Triton orientalis* DAVID, Journ. Trois. Voy. Chinois, vol. 1, p. 32 (type-locality, Tche-san [near Chüchow fu], Chekiang Prov., China; types in Paris Mus.; A. David, collector); vol. 2, 1875, p. 215 (Tsitou, southern Kiangsi); pp. 233, 238 (Mi-Ouan, Kiangsi).

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[3] See Herp. Japan, p. 7.

[4] I have accepted, at least provisionally, Doctor Dunn's dictum (Bull. Mus. Comp. Zoöl., vol. 62, no. 9, 1918, p. 448) with regard to the nomenclature of these salamanders in place of *Diemictylus* employed in Herp. Japan, 1907, p. 15.

1882. *Molge pyrrhogastra* Boulenger, Cat. Batr. Grad. Brit. Mus., p. 19 (part: Kiukiang Mts., China) (not of Boie).—Boettger, Offenbach. Ver. Naturk., 24–25 Ber., 1885, p. 165.—Werner, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p. 371.

1906. *Triton pyrrhogaster* subsp. *orientalis* Wolterstorff, Zool. Anz., vol. 30, 28, Aug. 1906, p. 558 (Wusüch, and 25 miles inland from Cheechow [Kichow?], Hupeh); Abh. Mus. Magdeburg, vol. 1, 1906, pp. 132, 153, pl. 1, figs. 3–6.

A single specimen (No. 65523) of this interesting species has been sent to the Museum by Prof. C. Ping, from the neighborhood of Nanking. It agrees in almost every respect with the detailed descriptions by Doctor Wolterstorff, especially with his No. 5. The black collar, already mentioned by Père David, is present and there is no red spot at the angle of the mouth.

Genus PACHYTRITON Boulenger

1878. *Pachytriton* Boulenger, Bull. Soc. Zool. France. vol. 3, 1878, p. 72 (monotype, *Triton brevipes* Sauvage).

PACHYTRITON BREVIPES (Sauvage)

1875. *Cynops chinensis* David, Journ. Trois. Voy. Chinois, vol. 2, pp. 231, 239 (Tsitou, southern Kiangsi) (not of Gray 1859).

1877. *Triton brevipes* Sauvage, Bull. Soc. Philom. Paris (7), vol. 1, 1877, p. 117 (type-locality, southern Kiangsi, China; types in Paris Mus.; A. David, collector).—*Pachytriton brevipes* Boulenger, Bull. Soc. Zool. France, vol. 3, 1878, p. 72; Cat. Batr. Grad. Brit. Mus., 1882, p. 30, pl. 1 (South Kiangsi).—Boettger, Offenbach. Ver. Naturk., 24–25, Ber., 1885, p. 165; 26–28 Ber., 1888 (p. 168).—Werner, Abr. Bayer. Akad. Wiss., II Kl., vol. 22, no. 2, 1903, p. 371.

Of this rare species which apparently has not been collected since Père David sent the type material to the Paris Museum in 1873, the National Museum has received two splendid specimens (Nos. 65341–2) from Mr. Sowerby. Père David who believed that he had *Cynops chinensis*, which Swinhoe had shown him in Shanghai, because they were larger than his *Triton orientalis* and had the underside yellow with black spots, collected his specimens not far from Tsitou in the mountains of southern Kiangsi near the border of Fukien. Mr. Sowerby's specimens are from Yen-ping-fu, Fukien, thus extending the range of the species considerably. They agree perfectly with Boulenger's excellent illustration of one of the cotypes.

Family HYNOBIIDAE

SALAMANDRELLA KEYSERLINGII Dybowski

Herp. Japan, 1907, p. 37. To synonymy add:

Nikolski, Fauna Rossij, Amphib., 1918, p. 236 (Ural to Kamchatka; northern Mongolia).

Hynobius keyserlingii Dunn, Proc. Amer. Acad. Arts Sci., vol. 58, June, 1923, p. 461 (Siberia; Kamchatka; Manchuria).

As the female specimen (No. 53366) collected by Mr. Sowerby at I-mien-po, northern Kirin, Manchuria, has already been mentioned by Dunn, as quoted above, I need make no further remarks here.

Genus BATRACHUPERUS Boulenger

1878. *Batrachuperus* BOULENGER, Bull. Soc. Zool. France, vol. 3, 1878, p. 71 (monotype, *Salamandrella sinensis* Sauvage).

1882. *Batrachyperus* BOULENGER, Cat. Batr. Grad. Brit. Mus., p. 37 (emendation).

1912. *Batrachypterus* BARBOUR, Mem. Mus. Comp. Zoöl., vol. 40, no. 4, p. 126 (err. typogr.).

BATRACHUPERUS PINCHONII (David)

1871. *Dermodactylus pinchonii* DAVID, Nouv. Arch. Mus. Hist. Nat. Paris, vol. 7, Bull. p. 95 (type-locality, Moupin).

Dermodactylus pinchonii DAVID, Journ. Trois. Voy. Chinois, vol. 2, 1875, p. 216.

1877. *Salamandrella sinensis* SAUVAGE, Bull. Soc. Philom. Paris (7), vol. 1, p. 117 (type-locality, Moupin, Szechwan, China; types in Paris Mus., A. David, collector).

Batrachuperus sinensis BOULENGER, Bull. Soc. Zool. France, vol. 3, 1878, p. 72.—DUNN, Proc. Amer. Acad. Arts Sci., vol. 58, 1923, p. 520 (Szechwan).

Batrachyperus sinensis BOULENGER, Cat. Batr. Grad. Brit. Mus., 1882, p. 37 (Moupin).—BOETTGER, Offenbach. Ver. Naturk., 24–25 Ber., 1885, p. 166 (Mupin).—GUENTHER, Ann. Mus. Zool. St. Pétersbourg, vol. 1, 1896, p. 209 (Sung-pan and Kuo-chu-chin, Szechwan).—WERNER, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p. 371.—DUNN, Bull. Mus. Comp. Zoöl., vol. 62, 1918, p. 456 (Liang-hoko Szechwan).

Batrachypterus sinensis BARBOUR, Mem. Mus. Comp. Zoöl., vol. 40, no. 4, 1912, p. 126, pl. 1, fig. 1, (Lianghokow, W. Szechwan, alt. 12,000 feet).

1898. *Salamandrella keyserlingii* BEDRIAGA, Wiss. Res. Przewalski Central-Asien Reis., Zool., vol. 3, pt. 1, May 15, 1898, p. 3 (part: Rivers Kserntso and Lumbu, Szechwan).

Doctor Dunn has treated so exhaustively of this species and described our specimens so fully that I need only record here the gratifying fact that Rev. D. C. Graham has sent the National Museum four fine specimens (Nos. 64419–22) which he collected on Mount Omei, Szechwan. The following interesting note accompanied the specimens: "The salamanders were caught in the White Dragon Pool on summit of Mount Omei, 11,000 feet above sea level, on August 20, 1921. They are called white dragons by the Buddists and the imaginary White Dragon king is worshiped in a small temple near the pool. The Chinese say that if one captures and kills one of these salamanders a storm will follow."

Since the above was written he has forwarded a young specimen (No. 67835) collected at the Yellow Dragon Gorge, near Sungpan.

No. 10995 was received from the Paris Museum as one of the types of this species, but the locality Kiangsi is attributed to it. This is

probably due to a confusion with David's types of *Pachytriton brevipes* which came from that province. His types of *B. sinensis*, however, were taken in Moupin, and there can be but little doubt that the latter is also the locality of our specimen.

Order SALIENTIA

Family DISCOGLOSSIDAE

BOMBINA ORIENTALIS (Boulenger)

Herp. Japan, 1907, p. 51, pl. 7. Add to synonymy:

Bombinator orientalis Wolterstorff, Abh. Mus. Magdeburg, vol. 1, 1906, p. 132 (Tsingtau; Masampo, Korea).

Bombina orientalis Nikolski, Fauna Rossij, Amph., 1918, p. 177 (Primorsk. Government; Iliampo, Railway Sta., East. Chinese R. R., Manchuria, etc.).

Eight splendid specimens (Nos. 52345–52) were collected by Sowerby in Southern Manchuria, at the Yalu River, about 180 miles from its mouth. Recently, Prof. C. Ping has sent three specimens (Nos. 66849–51) from Chefu.

Family BUFONIDAE

BUFO BUFO ASIATICUS (Steindachner)

For synonymy and illustrations see Herp. Japan. 1907, pp. 66–67, figs. 49–52. Add to synonymy:

Bufo vulgaris Wolterstorff, Abh. Mus. Magdeburg, vol. 1906, p. 131 (Pingshiang; Hankow; Chinkiang; Kiukiang; Shanghai; Tsingtau).—Sowerby, in Clark and Sowerby, Through Shen-Kan, 1912, p. 112 (Shansi).

Bufo bufo asiaticus Nikolski, Fauna Rossij, Amph., 1918, p. 126 (Ussuri; Vladivostok; etc.).

The accumulation of toads since the issue of the Herpetology of Japan, among which the splendid series from the type-locality of *B. asiaticus*, throws considerable light on the variation of the eastern forms of *B. bufo*, without affording conclusive evidence as to the distinctness of the groups recognized by name at the present time. On the other hand, there is not enough difference shown to justify their treatment binominally. There is therefore no warrant for disturbing the nomenclature of the Herpetology of Japan and the Fauna of Russia as yet.

The character relied upon to distinguish *B. asiaticus* from *B. japonicus*, viz., the unifrom pale or slightly dark-spotted underside does not hold at all. As a matter of fact, in the 20 grown and half-grown specimens from Shanghai nearly all have the underside strongly marked with black undulating and anastomosing blotches, and only one, the smallest (No. 66347, total length 41 mm.) is un-

spotted, while all the very young ones, 25 mm. and under, are likewise unspotted.

The chief color difference, therefore, seems to be the blackish lateral band in continuation of the lower blackish edge of the parotoid, which appears to be fairly constant in the adults of the eastern form. The alleged larger size and greater distinctness of the tympanum is not particularly noticeable in the series before me. On the other hand, the length of the first toe as compared with the adjoining metatarsal tubercle is relatively greater in the Chinese specimens than in the European ones examined by me.

A series of seven specimens collected by Graham at Tatsienlu, between 8,500 and 12,000 feet altitude, is particularly interesting. They are rather dark in color with the whole underside, except throat, darkly marbed and spotted. The tympanum is rather small, but the first toe is characteristically long. A close comparison with specimens of corresponding sex and age from Shanghai has not revealed any differences.

The specimens of this form now in the Museum in addition to those listed in the Herpetology of Japan are as follows:

46617. Shanghai, collected by D. C. Jansen.
49642–3. Vicinity of Tai-yuan-fu, Shansi. A. de C. Sowerby.
52353, 52355–6. Southern Manchuria, Yalu River, about 180 miles from its mouth. A. de C. Sowerby.
52566–8. Kiangyin, Kiangsu Prov. L. I. Moffett.
53369. Manchuria, Hei-Hong-Chiang, Sungari River near its junction with the Amur. A. de C. Sowerby.
60879–80. Chili, Hsin-Lung-Shan, near Imperial Hunting Grounds. A. de C. Sowerby.
65216–24. Shanghai. A. de C. Sowerby.
65339–40. Shanghai. A. de C. Sowerby.
66340–47. Shanghai. A. de C. Sowerby.
66461–2. Hangchow, Chekiang. A. de C. Sowerby.
66542–6. Tatsienlu, Szechwan (8,500–12,000 feet alt.). D. C. Graham.
66646–7. Tatsienlu, Szechwan (11,500 feet alt.). D. C. Graham.
66790–1. Suifu, Szechwan. D. C. Graham.
66852. Nanking. C. Ping.
66853. Wenchow. C. Ping.

BUFO BANKORENSIS Barbour

1908. *Bufo bankorensis* BARBOUR, Bull. Mus. Comp. Zoöl., vol. 51, no. 12, April, 1908, p. 323 (type-locality, Bankoro, Central Formosa; cotypes, No. 2432 Mus. Comp. Zoöl., Owston collection); Proc. New England Zoöl. Club, 4, November, 1909, p. 55, pl. 6.—STEJNEGER, Proc. U. S. Nat. Mus., vol. 38, May 3, 1910, p. 94.

Like the many Formosan species, related to Himalayan forms, which have turned up in China, the presence of this toad or a closely allied form might have been predicted. Nevertheless, it is very

gratifying to find in the collections from Mr. Graham two full-grown females, No. 63412, from Suifu, and No. 65922 from Shen-Kai-Si, Szechwan, at an elevation of 9,400 feet. These I have been able to compare with an extensive series of typical Formosan specimens, and have been unable to discover any tangible differences which would justify even a subspecific designation. Nor am I able to detect any particular deviation in the direction of *Bufo himalayanus* which might have been expected in view of the relationship and closer geographic proximity to the latter.

Bufo bankorensis is easily recognized by the broad, flat, and smooth surface of the top of the head. The resemblance to *B. melanostictus* is merely superficial.

BUFO RADDEI Strauch

For synonymy and illustration see Herp. Japan, 1907, pp. 70–71, figs. 53–57. Add to synonymy:

Bufo raddei ELPATJEWSKY and SABANEJEW, Zool. Jahrb. Syst., vol. 24, pt. 4, Dec. 1906, p. 262 (Kiakhta, etc.).—SOWERBY, in Clark and Sowerby, Through Shen-Kan, 1912, p. 112 (Shensi, Kansu).—NIKOLSKI, Fauna Rossij, Amph., 1918, p. 93 (Peking, Che-fu, Ordos, Alashan, Ussuri, Koko-nor, etc.).

1898. *Bufo raddei,* var. *przewalskii* BEDRIAGA, Wiss. Res. Przewalski Central-Asien Reis., Zool., vol. 3, sect. 1, pt. 1, p. 48, pl. 1, fig. 6 (type locality Koko-nor; type, Petrograd Mus. no. 2010; Przhevalski, collector).

1898. *Bufo raddei,* var. *pleskei* BEDRIAGA, Wiss. Res. Przewalski Central-Asien Reis., Zool., vol. 3, sect. 1, pt. 1, p. 48 (type-locality, Tola River near Urga, Mongolia; type, Petrograd Mus. No. 1261; Pewtzow, collector).

1910. *?Bufo nouettei* MOQUARD, Bull. Mus. Nat. Hist., Paris, 1910, p. 152 (type-locality, Sachow and Suchow, Kansu; Kashgar, Sinkiang; types in Paris Mus.; Dr. Louis Vaillant, collector).

The three forms recognized nomenclatorially by Bedriaga were not claimed by him to represent subspecies in the usual sense. Elpatjewsky and Sabenejew confirm this, but express the suspicion that these color phases may be due to differences of sex or age.

Twenty-six specimens received from Sowerby, partly collected by himself in Shensi and Kansu and by A. L. Hall at Hei Sui, northern Chili, close to the Mongolian border, throw considerable light on these questions. The Kansu specimens (Nos. 39368–73, six adult males) were collected at Chen-Kow-Yi, 52 miles east of Lanchowfu at 6,700 feet altitude, on July 18, 1909; those from Shensi as follows: No. 39378, a young specimen, at Hai-shan-ssu, at 3,600 feet altitude, on August 26; Nos. 39374–6, three young ones, 30 miles east of Yenanfu, 3,100 feet altitude, August 26; and No. 39377, adult female, at Yellow River, 40 miles east of Shui-teh-chow, 2,300 feet above the sea. Unfortunately the north Chili specimens, Nos.

53371–3 and 53379–89 are without date, but as the breeding asperities of all the males are in the same condition as those of the Shensi and Kansu specimens they are fully comparable. Of these 14 specimens, 12 are adult males and two adult females. The males are practically all uniform olive gray on the back with the warts pale (possibly red in life), but the regular pattern of spots can be discovered in most of them on the paratoid glands and on the tibia. In the two females the typical brown pattern of spots is strongly contrasted against the paler ground color. The Kansu and Shensi specimens are of a slightly paler ground color. Those from Kansu are all males and present an unbroken series of transition from a specimen (No. 39373) hardly distinguishable from the most uniform Chili male to one (No. 39369) with a pattern as contrasted as that of the Chili females. Among the Shensi specimens the adult female and the largest young one are pale with normal well-developed and contrasted pattern; the three smallest are also pale, but the dusky markings are less broad and on the back confined to rings around the pale (reddish?) warts; they are better defined on upper eyelid, lores, and legs.

It will thus be seen that we have no female or young specimens of the uniform dusky type, the males from the Kansu locality show a complete gradation between the two types of coloration which thus can not be said to be absolutely diagnostic of the two sexes. Nevertheless, the distinction is probably more or less general. Sowerby made the same observation in the field. In "Through Shen-Kan" he writes as follows (p. 112): "Radde's toad (*Bufo raddei*) is characteristic of the country. This amphibian does not attain any great size. The female is very prettily marked, somewhat resembling the natterjack of Europe; the male is of a dull greenish brown color, and does not posses the beautiful marking of the female. There can be no doubt of this animal's power to withstand drought. I have found it amongst the sand-dunes of Ordos, as well as in the loess hills of other parts. Specimens were secured in Kansu, within the famine area near Len-chow Fu. Here, the natives said, there had been no rain for three years. In spite of its frequenting such dry places, it thoroughly appreciates an abundant supply of water, as I have found them in the ponds and back-waters of rivers, not only while spawning but at all times of the year, excepting winter. The spawning season is regulated by the rains, and in a dry year I have known it to be postponed till July."

As Bedriaga [5] and Nikolski [6] have listed specimens in the Petrograd Museum (Nos. 1052, 1655, and 1658) collected by Potanin in North China and Mongolia as true *Bufo viridis*, I have naturally examined

[5] Wiss. Res. Przewalski Central-Asien Reis., Zool., vol. 3, sect. 1, pt. 1, 1898, p. 61.

[6] Fauna Rossij, Amph., 1918, pp. 101, 102.

all our specimens with the possibility in view that some of them might belong to this western form, but with negative results.

BUFO MELANOSTICTUS Schneider

For synonymy and illustration see Herp. Japan, 1907, pp. 72–73, figs. 58–61. Add:

WOLTERSTORFF, Abh. Mus. Magdeburg, vol. 1, 1906, p. 132 (Canton).—VOGT, Sitz. Ber. Ges. Naturf. Freunde, Berlin, 1914, p. 102 (Kwangtung).

Wolterstorff (see synonymy) seems to think that this species does not reach Fukien. However, six specimens collected by Sowerby in that province, including one without specific locality (No. 65267), four at Foochow (165328–9, 66427–8), and one at Fatsing (No. 65250), prove that the species is not rare there.

Genus AELUROPHRYNE Boulenger

1919. *Aelurophryne* BOULENGER, Rec. Indian Mus., vol. 16, December, 1919, p. 469 (type, *Bufo mammatus* Guenther).

AELUROPHRYNE MAMMATA (Guenther)

1896. *Bufo mammatus* GUENTHER, Ann. Mus. Zool. Acad. Sci. St. Pétersbourg, vol. 1, 1896, p. 208 (type-locality, Tung-so-lo [Tung-ngo-lo?], Kham plateau, Szechwan, China; types in Mus. St. Petersburg; G. Potanin, collector).—WERNER, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p. 370.—NIEDEN, Tierreich, vol. 46, Amph. Anura, pt. 1, 1923, p. 88.—*Aelurophryne mammata* BOULENGER, Rec. Indian Mus., vol. 16, December, 1919, p. 470 (Kashmir).

1917. *Rana pleskei* ANNANDALE, Rec. Indian Mus., vol. 13, 1917 (p. 417, figs. 1–2) (tadpoles; Kashmir, India) (not of Guenther).

Three specimens, one adult (No. 67833) and two adolescent ones (Nos. 67836–7), the former from Sungpan, the latter from the Yellow Dragon Gorge, east of this city, were collected by Mr. Graham, a most interesting addition to our collection.

Family HYLIDAE

HYLA CHINENSIS Guenther

To synonymy in Herpetology of Japan, 1907, p. 86, add:

Hyla chinensis STEINDACHNER, Wiss. Ergebn. Reise Szechenyi Ostasien, vol. 2, 1896, p. 507 (Shanghai).—WOLTERSTORFF, Abh. Mus. Magdeburg, vol. 1, 1906, p. 132 (Foochow; Nimrod Sound).—VOGT, Sitz. Ber. Ges. Naturf. Freunde, Berlin, 1914, p. 102 (Kwangtung).

Hyla arborea, var. *sinensis* GEE, Journ. N. China Asiat. Soc., vol. 50, 1919, p. 184 (Soochow).

Sowerby has sent eight specimens, old and young, from Fukien, viz., three from Foochow (Nos. 65337, 66403–4) and five from Futsing District. All have the characteristic black spots, even the youngest (80 mm. long).

HYLA ARBOREA JAPONICA Guenther

Herp. Japan, 1907, p. 76, pl. 9, figs. 1–3.

The material of tree toads received since the publication of the Herpetology of Japan is so insignificant that it throws very little light, if any, on the question of the distinctness and distribution of *H. arborea japonica*, *immaculata*, and *stepheni*. Nikolski has recently added another subspecies, *Hyla arborea ussuriensis*, based on a single specimen collected by Emeljanof in the neighborhood of Tchernigovki Village, in the Coast Province.[7] It is characterized by having the skin of the underside not granular but divided up into a mosaic of large polygonal plates and by having the third toe distinctly longer than fifth, etc. Not having seen any such specimen, I am unable to express any opinion as to the validity of this form.

Sowerby collected an adult male (No. 52354) in southern Manchuria on the Yalu River about 180 miles from its mouth. I am unable to distinguish it from Japanese specimens. The inner metatarsal tubercle, it is true, is rather large, and the digital disks perhaps rather small, but each can be matched in my Japanese series, though perhaps not in the same individual.

HYLA STEPHENI Boulenger

Herp. Japan, 1907, p. 84. Add to synonymy:

NIKOLSKI, Fauna Rossij, Amph., 1918, p. 149 (Ussuri country to Transbaicalia).

Two young specimens (Nos. 53367–8), largest 21 mm. long, were collected by Sowerby at Imien-po, northern Kirin, Manchuria, and are referred to under this heading in spite of the fact that I can make out no markings. The digital disks, however, are scarcely noticeable as such and the inner metatarsal tubercles are large.

I am now inclined to think that the three specimens from Mongolia in the Museum of the Philadelphia Academy alluded to in the Herpetology of Japan (p. 83), under the heading of *Hyla arborea immaculata*,[8] really are identical with Sowerby's Manchurian specimens.

Family BREVICIPITIDAE

MICROHYLA EREMITA Barbour

1858. *Diplopelma ornatum*, var. *B* GUENTHER, Cat. Batr. Sal. Brit. Mus., p. 50 (part only: Ningpo).

1864. *Diplopelma pulchrum*, GUENTHER, Rept. Brit. India, p. 417 (part only: Ningpo).

1882. *Microhyla ornata* BOULENGER, Cat. Batr. Sal. Brit. Mus., p. 165 (part only: Ningpo).—BOETTGER, Offenbach. Ver. Naturk., 24 und 25 Ber.,

[7] Fauna Rossij, Amph., 1918, p. 147.

[8] Described by Boettger from Shanghai.

1885, p. 162 (part only: Ningpo); Kat. Batr. Mus. Senckenberg, 1892, p. 23 (part: Dalanshan); Ber. Senckenberg. Naturf. Ges., 1894, p. 149 (Dalanshan and Chinhai, near Ningpo).—Werner, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p. 370 (part only: Ningpo).

1920. *Microhyla eremita* Barbour, Occas. Pap. Mus. Zool. Michigan, No. 76, March 1, 1920, p. 3 (type-locality, Nanking, China; type, Mus. Comp. Zoöl. No. 5114; Cora D. Reeves, collector).

Sowerby collected a single specimen (No. 65338) at Shanghai. Thanks to the courtesy of Dr. Barbour, direct comparison with one of the paratypes of *M. eremita*, recently described by him from Nanking has enabled me to verify the identification. The National Museum also possesses several specimens (Nos. 52569–72) from Kiangyin, Province of Kiangsu, half-way between Nanking and Shanghai, presented by L. F. Moffett.

MICROHYLA FISSIPES Boulenger

1884. *Microphyla fissipes* Boulenger, Ann. Mag. Nat. Hist., ser. 5, vol. 13, p. 397 (type locality, Taiwanfu, southern Formosa; type in British Museum); Ann. Mag. Nat. Hist., ser. 8, vol. 4, Dec., 1909, p. 495 (Kosempo and Kanshirei, Formosa.)—Boettger, Offenbach. Ver. Naturk., 24 und 25 Ber., p. 162 (Formosa).—Werner, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p. 369 (Taiwan).—Stejneger, Herpet. Japan, 1907, p. 88 (Formosa); Proc. U. S. Nat. Mus., vol. 38, May 3, 1910, p. 95 (Formosa).—Vogt, Sitz. Ber. Ges. Naturf. Freunde, Berlin, 1911, p. 181 (Formosa); 1914, p. 101 (Canton).

Of this species, originally described from Formosa, and recorded from southern China by Vogt in 1914, Mr. Sowerby has sent one from Futsing (No. 65256) and three from Yen-ping-fu (Nos. 65303–65305). I have carefully compared them with a large series from Formosa and can find no tangible difference. It is interesting to note that just as this species seems to be found in Formosa in the same locality as *M. heymonsi*, so Mr. Sowerby's lot of *M. fissipes* from Yen-ping-fu included also a specimen of *M. heymonsi*.

The discovery of these two species of Formosan Microhylas in Fukien is in perfect harmony with the close zoogeographic relationship of that island to the mainland. It will be recalled that in my paper on the Formosan Batrachians and Reptiles[9] I came to the conclusion that "all the [Formosan] batrachians which have Himalo-Chinese affinities have differentiated into more or less distinct species, while those of southern affinities have remained practically unaltered in the island." As *Microhyla* is a distinctly southern genus, with no Himalayan affinities, identity of the Fokien species with the Formosan ones is not surprising.

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[9] Proc. U. S. Nat. Mus., vol. 38, 1910, p. 93.

MICROHYLA HEYMONSI Vogt

1911. *Microhyla heymonsi* Vogt, Sitz. Ber. Ges. Naturf. Freunde, Berlin, 1911, p. 181 (type locality Formosa; types in Berlin Mus.; Sauter, collector); 1913, p. 224.

A single specimen of this species hitherto known only from Formosa (No. 65302) is among the lot of *M. fissipes* collected by Mr. Sowerby at Yen-ping-fu Fukien. It is matched perfectly by a large series of Formosan specimens before me. The two species, which apparently occur together, are very distinct and easily differentiated.

MICROHYLA GRAHAMI Stejneger

1924. *Microhyla grahami* Stejneger, Occ. Pap. Boston Soc. Nat. Hist., vol. 5, July 21, 1924, p. 119 (type-locality, Suifu, Szechwan, China; type, U.S.N.M. No. 65936; Rev. D. C. Graham, collector).

Diagnosis.—Interorbital space almost twice as wide as upper eyelid; skin above, including head and legs, strongly tubercular; toes with mere rudiment of web at base and scant indication of lateral dermal margins; tips of digits very slightly widened; heel of extended hind leg reaches middle of eye; two metatarsal tubercles.

Description of type specimen.—Snout slightly longer than diameter of orbit; interorbital space about one and a half the width of upper eyelid; first finger much shorter than second, tips of all scarcely widened; toes with a rudiment of web at base and scant indication of lateral dermal margins, tips of digits very slightly widened, not expanded into disks, but with indication of a median groove on top; subarticular tubercles well developed; two metatarsal tubercles, prominent, rather small, outer larger than inner; hind limb being carried forward along the body, the tibio-tarsal joint reaches middle of eye; tibia longer than half the length of head and body; skin above, including upper surfaces of head and legs, strongly tubercular, the tubercles somewhat elongate and varying in size, arranged in regular longitudinal rows, the one on the median line almost a continuous string of smaller tubercles; under surfaces smooth, except a small granular area between the femurs; a groove from posterior angle of eye to insertion of foreleg where it bifurcates, bordered below by a series of tubercular glands.

Color (in alcohol): Dark drab; a darker, almost blackish dorsal mark between eyes, with a lateral projection between the forelegs, to middle of back where it bifurcates and continues to the groin, followed on the lower back by a chevron-shaped mark which continues on the upper surface of the femur; a dark bend from above the foreleg to the middle of the flanks; a well-marked blackish spot on the anal region; limbs, including digits, with dark crossbars, a pale oblique stripe from posterior angle of eye to foreleg; underside pale, densely spotted with dark gray, except on middle of belly.

DIMENSIONS

	mm.
Total length from snout to vent	18
Greatest width of body	7
Width of head at posterior angle of eye	5
Tip of snout to eye	3
Tip of snout to insertion of front leg	7.5
Diameter of eye	2.25
Foreleg	9.5
Vent to heel	15
Heel to tip of fourth toe	14
Outer metatarsal tubercle to tip of fourth toe	9.5
Tibia	10

Remarks.—Of this new species there is another specimen (No. 65937) besides the type. It is a millimeter longer, otherwise in most details identical, though the serial arrangement of the dorsal tubercles is not quite so regular.

The species seems to be smaller than the related ones, is quite rough above, and very much darker colored. The pattern is essentially that of *M. fissipes*, except that the dorsal mark is wider anteriorly and the lateral band shorter, starting only on the shoulder.

In the roughness of its upper surfaces it surpasses the *M. sowerbyi*, to be described next, but the rudimentary webs and lack of digital disks differentiate it at once.

It is with great pleasure that I dedicate this interesting novelty to its discoverer, Rev. D. C. Graham.

MICROHYLA SOWERBYI Stejneger

1924. *Microhyla sowerbyi* STEJNEGER, Occ. Pap. Boston Soc. Nat. Hist., vol. 5, July 21, 1924, p. 119 (type-locality, near Yen-ping-fu, Fukien, China; type, U.S.N.M. No. 65309; A. de C. Sowerby, collector).

Diagnosis.—Interorbital space slightly wider than upper eyelid; skin above, including head and legs, densely tubercular; toes scant one-third webbed, with rather wide dermal margins and well-developed disks; heel of extended hind leg reaches between eye and tip of snout; two prominent, though small, subequal metatarsal tubercles.

Description of type.—Snout slightly longer than diameter of orbit; interorbital space slightly wider than upper eyelid; first finger much shorter than second, tips of all widened; toes with a well-developed web not quite one-third and rather wide dermal margins; tips widened into distinct disks with indication of a groove on top; subarticular tubercles prominent; two metatarsal tubercles, subequal, small, scarcely larger than a subarticular tubercle, prominent and rather pointed; hind limb being carried forward along the body, the tibio-tarsal joint reaches between the eye and the tip of snout; skin

above, including upper surfaces of head and legs, densely tubercular, the tubercles apparently without any definite arrangement in rows, except perhaps on the tibia; a slight fold from eye to foreleg, chiefly indicated by a groove in front of it; underneath smooth, except belly, which is granular.

Color (in alcohol): Drab gray above, whitish beneath; a blackish zigzag crossband from shoulder to shoulder, overlying a fainter, more brownish median dorsal mark from between eyes to sacrum, with a lateral oblique projection extending backwards half way between axilla and groin; no anal or post-femoral spots; legs more or less distinctly cross-barred; no trace of a dark lateral band on head or body; no pale line down the middle of the back.

DIMENSIONS

	mm.
Total length from snout to vent	22
Greatest width of body	11
Width of head at posterior angle of eye	6.5
Tip of snout to eye	3
Tip of snout to insertion of front leg	8.5
Diameter of eye	2.5
Fore leg	12
Vent to heel	22
Heel to tip of fourth toe	18
Outer metatarsal tubercle to tip of fourth toe	11.5
Tibia	12

Remarks.—This new species, which I take great pleasure in naming for its discoverer, does not seem to be very closely related to any of the known species. In its dorsal tubercles, though not quite as rough, it recalls *M. grahami*, but in other characters it differs widely. As in so many *Microhylas* the color pattern is quite characteristic. In certain respects it recalls *M. fissipes*, but the lateral projection of the median dorsal spot are more anterior, and the dark band on the sides of head and body is entirely absent.

Genus KALOULA Gray

1831. *Kaloula* GRAY, Zool. Miscell. (p. 38) (monotype, *K. pulchra*).

1838. *Hyladactylus* TSCHUDI, Mém. Soc. Sci. Nat. Neuchâtel, p. 48 (type, *H. baleatus*).

1838. *Hyladactyla* TSCHUDI, Mém. Soc. Sci. Nat. Neuchâtel, p. 85 (lapsus).

1841. *Hylaedactylus* DUMÉRIL and BIBRON, Erpét. Gén., vol. 8, p. 732 (emendation).

1841. *Plectropus* DUMÉRIL and BIBRON, Erpét. Gén., vol. 8, p. 736 (type, *P. pictus*).

1848. *Pelida* GISTEL, Naturg. Thierr., p. xi (substitute for *Hyladactylus*).

1863. *Calohyla* PETERS, Mon. Ber. Berlin Akad. Wiss., 1863, p. 454 (emendation).

1863. *Halonectes* PETERS, Mon. Ber. Berlin Akad. Wiss., 1863, p. 454 (type, *H. conjunctus*).

1864. *Callula* GUENTHER, Rept. Brit. India, p. 436 (emendation).

KALOULA RUGIFERA Stejneger

1924. *Kaloula rugifera* STEJNEGER, Occ. Pap. Boston Soc. Nat. Hist., vol. 5, July 21, 1924, p. 119 (type-locality, Kiating, Szechwan, China; type, U.S.N.M. No. 65520; Rev. D. C. Graham, collector).

Diagnosis.—Toes nearly one-third webbed at the base; fingers dilated into well-developed truncated disks; upper surface and sides with numerous elongated warts; interorbital space much wider than upper eyelid; both metatarsal tubercles large, with cutting edge, outer transverse.

Description of type specimen.—Tongue oval, slightly emarginate behind; behind the choanae on each side a curved strong ridge without teeth extending outward beyond the choanae and converging backward toward the median line, separated by a narrow interspace; snout rounded, slightly longer than diameter of eye; nostrils nearer the tip of the snout than the eye, the latter distance equaling the internaral distance; canthal ridge indicated; lores slightly concave; interorbital space much wider than upper eyelid; fingers slender with well-developed truncated disks, second equaling fourth, first somewhat shorter; subarticular and palmar tubercles prominent, the one at the base of the first finger with free rounded edge; toes long and slender, tips distinctly swollen, about one-third webbed at base; subarticular tubercles well developed; both metatarsal tubercles strongly developed with free cutting edges, the inner much larger, the outer transverse; extended hind leg reaches beyond the fore leg and eye; skin of upper surface and sides rough with numerous elongate wrinkled tubercles; underside more or less transversely wrinkled; preanal region granular; a slight dermal fold indicated by a faint groove from eye to shoulder; no fold across the top of head.

Color (in alcohol): Dark brownish gray above with a broad pale band, interruped in the middle, across the neck between the fore legs, this band edged with a series of small black spots: similar black spots scattered over the upper surface and forming a narrow band across supraorbital region, a line on upper lip and indication of cross bars on the legs and feet; underside light brownish gray with numerous roundish white spots on chin and throat; all tubercules on the underside of the feet distinctly whitish.

DIMENSIONS

	mm.
Total length from snout to vent	42
Greatest width of head	16.5
Tip of snout to eye	4.5
Interorbital width	4.5
Width of upper eyelid	3
Fore leg	30
Vent to tip of inner metatarsal tubercle	42
Tip of inner metatarsal tubercle to tip of fourth toe	17

Remarks.—This novelty is somewhat intermediate between *Kaloula pulchra*, from Hongkong and southern China and *Kaloula verrucosa*, described by Boulenger[10] from Yunnanfu.[11] The web between the toes is intermediate in extent, being larger than in *K. pulchra*[12] but shorter than in *K. verrucosa*, as represented by two specimens in our Museum from the type locality, which were obtained from the Museum of Comparative Zoölogy, though closely approaching that of No. 65520. In dilation of the fingers it agrees with *K pulchra*, but in the rugosity of its upper surface it even surpasses *K. verrucosa*. It differs from the latter, and judging from the descriptions, also from the former, in the longer snout and better developed canthus rostralis. It agrees again with *K. pulchra* in the wider interorbital space. It differs from both decidedly in the pattern of coloration which is peculiar and characteristic.

Another *Kaloula* has been described ten years ago as *K. tornieri*,[13] from Korea, the most easterly extension of the genus known. It differs by having no well-defined disks on the fingers, by a small, rounded outer metatarsal tubercle, etc., and does not seem to be nearly related to the above.

That the new species belongs to the genus *Kaloula* I have no doubt, in spite of the fact that the sternal apparatus resembles very closely the figure given by Boulenger[14] of that of *Cacopus systoma*. The inner nares and the palatal ridges agree so well, however, with our specimens of *K. verrucosa*, that a separation from the genus *Kaloula* is excluded. The terminal phalanx of the digits is shaped much like that of *K. verrucosa*.

Family RANIDAE

RANA NIGROMACULATA Hallowell

Synonymy, Herp. Japan, 1907, p. 94, to which add:

Rana, esculenta subsp. *chinensis* WOLTERSTORFF, Abh. Mus. Magdeburg, vol. 1, 1906, pp. 130, 135 (Foochow; Pingsiang, and Kiukiang, Kiangsi; Nimrod Sound, Chekiang; Shanghai; Nanking, Peking, Tsing-tao, Shantung; Masampo and Chemulpo, Korea).

Rana esculenta var. *chinensis* BOULENGER, Rec. Indian Mus., vol. 20, 1920, p. 88 (Shanghai; Chusan; Ningpo; Mts. n. of Kiukiang).

Rana chinensis BOLKAY, Allatt. Közl. Budapest, vol. 8, 1909 (p. 53, pl. 8); Proc. Washington Acad. Sci., vol. 13, 1911, p. 67, pl. 6 (critical).

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[10] Ann. Mag. Nat. His., ser. 7, vol. 13, February, 1904, p. 131.

[11] This species has also been reported from Tsingtau, Shantung (*Callula verrucosa* WOLTERSTORFF, Abh. Mus. Madgeburg, vol. 1, 1906, p. 145). Whether identical with the Yunnan form, or distinct, remains to be seen. Doctor Wolterstorff indicates various differences.

[12] As figured by Boulenger, Cat. Batr. Sal. Brit. Mus., 1882, p. 170.

[13] *Callula tornieri* VOGT, Sitz. Ber. Berlin Akad. Wiss., 1913, p. 219.

[14] Cat. Batr. Sal. Brit. Mus., 1882, p. 174.

Rana esculenta SOWERBY, in Clark and Sowerby, Through Shen-Kan, 1912, p. 112 (Shensi).—GEE, Journ. N. China Asiat. Soc., vol. 50, 1919, p. 184 (Soochow).

Rana nigromaculata ANNANDALE, Mem. Asiat. Soc. Bengal, vol. 6, 1917, (p. 140, pl. 6, fig. 4).—NIKOLSKI, Fauna Rossij, Amph., 1918, p. 34 (Ordos; Wuchangfu, Hupeh; Khingan Mts; etc.).

Of this widely distributed and common frog most of the recent collections contain numerous examples, as shown by the following enumeration.

Sowerby collected three specimens (Nos. 52360–2) in southern Manchuria at the Yalu River about 180 miles from its mouth; eight specimens (Nos. 39346–52) in Shensi at Yenanfu, and 20 miles east of Hai-shin-ssu; seven specimens (Nos. 65225–8, 66352–4) at Shanghai; eighteen (Nos. 65330, 66386–402) at Foochow, and three (Nos. 65292–4) near Yenpingfu, Fukien. One (No. 63202) was extracted from the stomach of a snake collected by Dr. Lewis R. Thompson in the southwestern part of Hunan province. Rev. Graham sent eleven from Szechwan, seven (Nos. 65931, 66642, 66785–9) from Suifu, the others (Nos. 65924–7) presumably from the same locality. L. I. Moffett collected two specimens (Nos. 52585–6) at Kiangyin, Kiangsu.

RANA PLANCYI Lataste

Synonymy, see Herp. Japan, 1907, p. 101, to which add:

BOETTGER, Offenbach. Ver. Naturk., 24–25 Ber., 1885, p. 160; Kat. Batr. Mus. Senckenberg., 1892, p. 4 (Lushan Mts. near Kiukiang; Shanghai; Hankow); Ber. Senckenberg. Naturf. Ges., 1894, p. 138 (Hankow); p. 140 (Lushan Mts.); p. 145 (Shanghai); p. 147 (Dalanshan, near Ningpo).—WERNER, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p. 368.—WOLTERSTORFF, Abh. Mus. Magdeburg, vol. 1, 1906, p. 130 (Ping-shiang; Nimrod Sound, Chekiang; Kiukiang).—GEE, Journ. N. China Asiat. Soc., vol. 50, 1919, p. 184 (Soochow).

ANNANDALE, Mem. Asiat. Soc. Bengal, vol. 6, 1917, p. 145 (Tai-hu Lake, Prov. Kiangsu).—BOULENGER, Rec. Indian Mus., vol. 20, 1920, p. 85 (China and Formosa).

There are now in the National Museum good series of this species both from Formosa and the Chinese mainland. An examination of this material demonstrates that the differences which I indicated [15] between specimens from Formosa and Shanghai do not hold and are of a purely individual character. Several of the specimens have well-developed glandular tubercles on the back between the dorso-lateral folds, but they do not assume the shape of elongated folds as in *R. nigromaculata*. The black and white band on the posterior aspect of the thigh is characteristic of *R. plancyi*. Our series now includes two specimens (Nos. 65331 and 65333) from Foochow, and one (No. 65258) from Futsing also in Fukien, and 12 specimens (Nos.

[15] Herp. Japan, 1907, p. 101.

65236–46, 66351) from Shanghai, all collected by Mr. Sowerby. In addition we have eight specimens (Nos. 52576–82, 52584) from Kiangyin, Kiangsu, collected by L. I. Moffett.

RANA ASIATICA (Bedriaga)

1853. *Rana cruenta* MIDDENDORFF, Sibir. Reise, vol. 2, pt. 2, p. 249, pl. 26, figs. 5–7 (Jakutsk, Siberia) (not of Pallas).

1876. *Rana temporaria*[16] STRAUCH, in Przewalski's Mongoliya i Strana Tangutov, vol. 2, pt. 3, p. 53 (Kansu; Ordos) (not of Linnaeus).—GUENTHER, Ann. Mus. Zool. St. Pétersbourg, vol. 1, 1896, p. 206 (Sungpan, Szechwan).

1885. *Rana japonica* BOETTGER, Offenbach. Ver. Naturk., 24–25 Ber., p. 150 (Kansu; Ordos; Szechwan) (not of Guenther).—SOWERBY, in Clark and Sowerby, Through Shen-Kai, 1912, p. 112 (North Shensi; Kansu).

1898. *Rana temporaria*, var. *asiatica* BEDRIAGA, Wiss. Res. Przewalski Central-Asien Reis., Zool., vol. 3, sect. 1, Amph. Rept., pt. 1, May 15, 1898, p. 23, pl. 1, fig. 4–4b (type-locality, Kansu and Ordos, Mongolia; cotypes, Petrograd Mus. Nos. 928, 929; Przhevalski, collector).

1909. *Rana bachtyana* KASTCHENKO, Ann. Mus. Zool. St. Pétersbourg, vol. 14, p. 129 (type-locality, Bachty, Semiryetchensk, Siberia; types in Univ. Tomsk).

1914. *Rana asiatica* NIKOLSKI, Trudi Troitsko-Savsk. Kiakht. Otd. Geogr. Obshtch., vol. 15, 1914 (p. 33) (Transbaikalia); Fauna Rossij, Amph., 1918, p. 62 (Southern Siberia, Davuria, Ordos, Kansu, etc.).

The exact relation of this form to the typical *Rana temporaria*, which inhabits the northern regions from the Atlantic Ocean to the Pacific, is not quite clear. In the desert regions from the Tian-Shan eastwards a form occurs apparently distinguished by longer snout, slightly longer hind legs, slightly more excised webs and more posteriorly located vomerine teeth. It is not always easy to determine, especially with indifferently preserved material, to which form a given specimen may belong. This is evident from an inspection of the lists of specimens given by Bedriaga and Nikolski, which shows that these eminent authorities have disagreed materially in the reference of the individual specimens, and that both authors enumerate specimens from the same locality under the separate names. Thus Bedriaga (p. 17) refers Petrogr. Mus. No. 1055, from the River Kungess in the Tian-shan to *Rana temporaria* and No. 1056 from the same locality to *R. asiatica*, while Nikolski (Fauna Rossij, Amph., p. 39) places both numbers under *R. temporaria*. Bedriaga regards the two specimens of No. 932, from Kansu, as typical *R. temporaria;* Nikolski has them under *R. asiatica*, and also

[16] In the Herpetology of Japan, p. 113, I explained the trivial term *temporaria* as signifying "temporary, in the present case, perhaps, in the sense of changeable." I have since come across the following paragraph in Gesner's "De Amphibiis" (1560, p. 360): "Latent hybernis mensibus in terra Ranae omnes exceptis temporariis istis minimis, qui latent in coeno, et reptant in viis ac ripis," showing that these frogs were called "temporary" because they were believed to last only during the summer time and not to hibernate like the other frogs.

No. 1056. Bedriaga has at least one of the eight specimens of No. 1501, from the River Braga-gorgi, as *R. asiatica*, while Nikolski has three out of the same batch under *R. asiatica* and three under *R. temporaria*. Moreover, Bedriaga refers Middendorff's specimens from Udskoi Ostrog to *R. asiatica*, while Nikolski keeps them in *R. temporaria* where, I have no doubt, they really belong.

Mehely's suggestion [17] that Middendorff's Aldan and Udskoi specimens, as well as Bedriaga's *R. asiatica*, really are *Rana arvalis* I simply mention to show how divergent the opinions are as to these frogs.

Recently [18] Boulenger has made *R. japonica* include specimens from practically the whole of China and Japan, from Canton and Yunnanfu to Yezo and the mouth of the Amur. This disposition of the east Asiatic grass frogs does not seem to meet the requirements of the case, and in the absence of a discussion and disposal of *R. martensi* and of *R. asiatica* I am unable to accept his view, at least for the present.

In this uncertainty I have preferred to follow Nikolski in treating this form binominally.

This is the form which Sowerby found all along his route with Colonel Clark in Shansi, northern Shensi, and Kansu in 1908 and 1909. A fine series, including specimens from Taiyuanfu, Shansi (Nos. 39326–30), Yulinfu, Shensi (Nos. 39331–2), 50 miles east of Yenanfu, Shensi (Nos. 39360–6), 25 miles northeast of Chingningchow, Kansu (Nos. 39354–9), and 20 miles east of Kingyangfu, Kansu, at Ho-shin (No. 39367) testify to his zeal and skill as a collector and observer. There are also in the collections received from him later on specimen obtained by A. L. Hall in northeastern Chili, at Hei Sui, close to the Mongolian border (Nos. 53374–8) and by himself in Manchuria, at I-mien-po, North Kirin (No. 53370).

RANA CHENSINENSIS David

This, as will be shown below, is the same as *Rana amurensis* Boulenger in the Herpetology of Japan, 1907, p. 119. To the synonymy there given add:

1875. *Rana chensinensis* DAVID, Journ. Trois. Voy. Chinois, vol. 1, p. 159 (type locality, Inkiapo, Valley of Laoyu, Tsinling Mts., southern Shensi: types in Paris Mus.; A. David, collector).

Rana amurensis ELPATJEWSKY and SABANIJEW, Zool. Jahrb. Syst., vol. 24, 1906, p. 261 (Transbaicalia).—BOULENGER, Proc. Zool. Soc. London, 1907, p. 414 (Sakhalin).—BARBOUR, Proc. New England Zoöl. Club, vol. 4, Nov. 24, 1909, p. 59 (West Tai-pai-shiang district, Northern China).

1912. *Rana japonica* SOWERBY, in Clark and Sowerby, Through Shen-Kan, p. 112 (north Shensi; Kansu) (part; not of Guenther).

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[17] Zichy's Dritte Asiat. Forschungsreise, vol. 2, Zool., 1901, p. 66.
[18] Rec. Indian Mus., vol. 20, 1920, p. 93.

1918. *Rana amurensis amurensis* Nikolski, Fauna Rossij, Amph., p. 80 (Vladivostok; Shmakovskaya, Ussuri).

1918. *Rana amurensis kukunoris* Nikolski, Fauna Rossij, Amph., p. 82 (type locality, Lake Kokonor, Tibet; cotypes, Mus. Petrograd, no. 1500; Przhevalski, collector).

Rana amurensis was originally described by Boulenger from specimens collected in the Russian Coast province. It was afterwards (1908) recorded by Bedriaga from material collected by Przhevalski and Grum-Grzymailo at Kokonor. Neither of these authors had seen specimens from the other's locality.

Nikolski was able to compare specimens from both localities which are more than 1,500 miles apart, and came to the conclusion that those from Kokonor were distinguishable from the typical Ussuri form by having the skin of the sides and belly smooth, back furnished with elongate tubercles, belly unspotted, and the inner metatarsal tubercle less than one-half the length of first toe.

While thus Bedriaga and Nikolski were unable to compare specimens from these extreme ends of the range of the species, I on the other hand have only specimens from the intermediate territory. Dr. Thomas Barbour, in 1909, recorded several specimens from the West Tai-pai-shiang district of Northern China. This locality which seems to be the same as Tei-pai-shan (also spelled Ta-pai-shan or Thaé-péy-chan), in the Tsinling Mountains south of Sianfu, Shensi, is not far from the place 15 miles south of Sianfu, where Sowerby collected two specimens (Nos. 39315–6) on February 26, 1909. Thanks to the courtesy of Doctor Barbour I have been able to compare the two grown specimens in the Museum of Comparative Zoölogy with ours and find them to agree in all essential points, and I have no doubt that they all represent *R. chensinensis* (=*amurensis*). To this form I also refer four specimens (Nos. 52363–6) taken by Sowerby in southern Manchuria on the Yalu River about 180 miles from its mouth, and five specimens, also collected by him in the Hsin-Lung-Shan district, Imperial Hunting Grounds, Chilili, 65 miles northeast of Peking, during the month of August, 1917. In most of these I find the skin on the sides and below rather smooth, the venter immaculate and the inner metatarsal tubercle rather less than one-half the inner toe, but the tubercles on the back are not elongated. In some respects therefore these Chinese specimens are intermediate and cast doubt upon the validity of the subspecies *kukunoris*.

The change of name of this species from *R. amurensis* to *R. chensinensis* is due to the discovery of the fact that Père David in the account of his trip from Sianfu to the Tsinling Mountains described this species under the latter name from some specimens caught on

November 19, 1872, in a small spring at an altitude of more than 1,000 meters near Inkiapo in the valley of Laoyu, Tsingling Mountains. The two specimens (Nos. 39315–6) collected by Sowerby on February 26, 1909, in a mountain stream 15 miles south of Sianfu, at an altitude of 1,500 feet are therefore practically topotypes of Père David's species. It is interesting to compare Mr. Sowerby's color description of some of his frogs as being "yellowish-pink beneath, shading into red on the under surfaces of the legs" with David's "d'un beau jaune au ventre, avec le dessous des bras rouges."

RANA JAPONICA (Guenther)

Herpetology of Japan, 1907, p. 107, pl. 11, fig. 1. Add to synonymy:

1870.—*Rana silvatica* SWINHOE, Proc. Zool. Soc. London, 1870, p. 412 (Ichang, Hupeh) (not *R. sylvatica* LECONTE).

Rana japonica STEJNEGER, Proc. Washington Biol. Soc., vol. 37, Feb. 21, 1924 p. 70 (Japan).

While writing the Herpetology of Japan, I had serious doubts about *R. japonica* being found outside of Japan, not having seen any Chinese specimens myself. However, I have now before me two specimens (U. S. Nat. Mus. Nos. 66459–60) collected by Sowerby at Hangchow, Chekiang, and one from Shin-Kai-Si, Mount Omei, Szechwan, collected by Mr. Graham (No. 66547), which I am unable to separate from Japanese specimens. It is, therefore, likely that the records of *R. japonica* from Ningpo, Chin-hai, Nanking, Shanghai, Nimrod Sound, Kiukiang, and Ping-shiang correctly refer to this species. On the other hand, I can not accept the view that the Peking and other northern Chinese specimens referred to it belong here. They are probably either *R. chensinensis* (*amurensis*) or *R. asiatica*.

RANA LONGICRUS Stejneger

1898. *Rana longicrus* STEJNEGER, Journ. Sci. Coll. Tokyo, vol. 12, pt. 3, 1898, p. 216 (type locality, Taipa, Formosa; type, Sci. Coll. Mus. Tokyo, No. 26; T. Tada, collector); Herpet. Japan, Bull. U. S. Nat. Mus., No. 58, 1907, p. 104; Proc. U. S. Nat. Mus., vol. 38, 1910, p. 95 (Formosa): Proc. Washington Biol. Soc., vol. 37, Feb. 21, 1924, p. 77 (Formosa).—WERNER, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p. 369 (Formosa).—BOULENGER, Rec. Indian Mus., vol. 20, 1920, p. 95 (Ching Fung Lin, Fukien).

Boulenger's record of this species as occurring in Fukien is corroborated by a specimen collected by Mr. Sowerby at Foochow (No. 65327). Thus one more species is added to the list of batrachians which Formosa has in common with the mainland opposite.

From the list of measurements of this specimen given below the interorbital space as compared with that of the type appears to be much narrower relatively to the eyelid, and the latter wider, a dis-

crepancy also apparent in the figure of the type[19], but that may be due to a difference in the state of preservation of the two specimens, as the total width between outer edges of eyelids, 10 mm., is identical in both.

DIMENSIONS

	mm.
Snout to vent	48
Snout to posterior edge of tympanum	16
Snout to corner of mouth	14.5
Width of head	14.5
Diameter of eye	5
Width of upper eyelid	3.5
Interorbital width	3
Eye to nostril	4
Eye to end of snout	7.3
Diameter of tympanum	3
Fore limb	28
Elbow to tip of longest finger	21
Hind limb	91
Vent to tip of longest toe	95
Thigh	24
Tibia	30
Inner metatarsal tubercle	2
Distance between dorso-lateral folds	8.3

RANA RICKETTI Boulenger

1899. *Rana ricketti* BOULENGER, Proc. Zool. Soc. London, 1899, p. 168, pl. 19, fig. 2 (type locality, Kuatun, Fukien; cotypes in British Mus.; J. D. La Touche, collector); Rec. Indian Mus., vol. 20, 1920, p. 216 (Fukien; Man Son Mountains, Tonkin, near Kwangsi).—VOGT, Sitz. Ber. Ges. Naturf. Freunde, Berlin, 1914, p. 100 (Kwangtung).

Mr. Sowerby collected a single specimen (U.S.N.M. No. 65266) near Yenpingfu, Fukien. Total length is 53 mm., consequently as large as the Tonkin specimens measured by Boulenger and considerably larger than the types (32 and 38 mm.).

RANA ADENOPLEURA Boulenger

1909. *Rana adenopleura* BOULENGER, Ann. Mag. Nat. Hist. (ser. 8), vol. 4, December, 1909, p. 492 (type locality, Fuhacho village, 4,000 feet altitude, Formosa; cotypes in Brit. Mus.; H. Sauter, collector); Rec. Indian Mus., vol. 20, 1920, p. 139 (Formosa).

A single specimen (No. 65248) of this rare frog, originally described from Formosa, was collected by Sowerby at Yenpingfu, Fukien, thus adding still another to the species of batrachians common to this province and Formosa. It agrees closely with Boulenger's description, except that the dorso-lateral fold starts from the upper eyelid and not "from above the tympanum." To his description I may add that the disks of the toes are broadly lance-

[19] Herp. Japan, fig. 81, p. 104.

olate, pointed anteriorly, and the horizontal groove very marked. A series of measurements of this interesting specimen is appended.

	mm.
Snout to vent	45
Length of head	16
Width of head	15.5
Snout to eye	8
Eye	5
Interorbital width	3.7
Upper eyelid	4
Tympanum	4
Fore leg	27
Hind leg	77
Tibia	24
Vent to tip of longest toe	80
First toe	6
Inner metatarsal tubercle	2.5

RANA GUENTHERI Boulenger

1867. *Hylorana malabarica* Steindachner, Reise Novara, Zool., vol. 1, Amph., p. 48 (Hongkong) (not of Duméril and Bibron).

1888. *Rana guentheri* Boulenger, Cat. Batr. Sal. Brit. Mus., p. 48, pl. 4, fig. 2(type locality, Amoy, China; cotypes in Brit. Mus.; R. Swinhoe, collector); Rec. Indian Mus., vol. 20, 1920, p. 133 (Amoy, China; Tonkin; Annam).—Boettger, Offenbach. Ver. Naturk., 24–25 Ber., 1885, p. 159 (Amoy); Ber., 1888, p. 95; Ber. Senckenberg. Naturf. Ges., 1894, p. 135 (Hainan); p. 137 (Hongkong); Kat. Batr. Mus. Senckenberg., 1892, p. 10 (Hainan; Hongkong, Canton).—Werner, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p. 309.—Wolterstorff, Abh. Mus. Magdeburg, vol. 1, 1906, pp. 126, 131, 144 (Pingshiang, Kiangsi; Canton).—Vogt, Sitz. Ber. Ges. Naturf. Freunde, Berlin, 1914, p. 100 (Kwantung).

A fine large male (total length 86 mm.), with large vocal sacs and humeral glands (No. 65332) a female, 77 mm. (No. 66465) and two young ones 24 and 22 mm. (No. 66466–7), were collected by Sowerby at Foochow, Fukien. Two half-grown specimens (Nos. 63413 and 65944) 64 and 57 mm. long, and a young one (No. 65935) 28 mm. long, were taken in Szechwan by Rev. D. C. Graham, the last mentioned at Suifu, the other probably at the same place. A fine male (No. 66848) has recently been received from Prof. C. Ping. It was collected at Nanking.

RANA TIBETANA Boulenger

1917. *Rana tibetana* Boulenger, Ann. Mag. Nat. Hist. (8 ser.), vol. 20, Dec. 1917, p. 414 (type locality, Yin-tsin-wau, Wassu State, Tibet; type in Brit. Mus.); Rec. Indian Mus., vol. 20, 1920, p. 70 (Yin-tsin-wan).

A single excellently preserved specimen of what I take to be Boulenger's *R. tibetana* was collected by Rev. D. C. Graham at Shin-kai-si, Mount Omei, Szechwan (U. S. Nat. Mus. No. 64423). At first glance it recalls *Rana rugosa* of Japan, but an inspection of

the hind feet at once discloses that it belongs to an entirely different group of the genus.

About five closely allied forms have been described or recorded from the surrounding regions, namely, *R. feae*, *yunnanensis*, and *phrynoides* from Yunnan, *spinosa* from southern China south of the Yangtse, and *tibetana* from a locality in Tibet. Of these the description of the last mentioned species agrees in almost all particulars with our specimen. It has a distinct tympanum which is about 0.6 the diameter of the eye; a tarsal fold; the tibio-tarsal articulation reaches the anterior angle of eye; the tibia is 3¼ times as long as broad, and about twice in length from snout to vent; first finger is longer than second; tips of toes swollen into small disks; inner metatarsal tubercles narrow, about 0.6 length of inner toe, no outer metatarsal tubercle; canthus rostralis quite distinct; loreal region concave; nostril nearer the eye than the end of the snout; distance between nostrils greater than interorbital width which is less than upper eyelid; heels overlapping; barely trace of a fold across the head behind the eyes, but a strong glandular fold from the eye to the shoulder. The upper parts in the type which is hitherto the only museum specimen recorded of *R. tibetana*, are described as "rough with granules and numerous round or oval warts tipped with black horny spinules." The wartiness of the Mount Omei specimen is apparently even more pronounced, for the skin of the whole upper surface resembles that of *R. rugulosa*, being densely granular with elongate narrow warts, 2 to 3 millimeters long, and arranged in about 8 fairly regular series on the back. The warts on the sides and upper surface of legs are shorter, but also arranged more or less serially, giving the whole upper surface a very rough appearance.

With regard to the type locality as given by Boulenger, I have failed to locate any Yin-tsin-wau or -wan in Tibet proper, nor a Wassu State. There is a Yin-tsin at the extreme eastern end of Szechwan in or near the Wu-shan range, but that is not likely to be the locality intended. There is, however, indicated on some maps an independent tribe (or state) Wasu or Wa-ssu in Central Szechwan near which a locality Wenchwan. Under the circumstances I feel that my identification of the species does no violence to the probable geographical distribution of this interesting frog, especially as Szechwan apparently has encroached upon Tibet by the absorption of the various independent kingdoms.[20]

A table of measurements of our specimen is appended for comparison with the dimensions given by Boulenger of the type. I have tried as far as possible to conform to his directions for taking the measurements.

[20] See Rockhill, Journ. Mongolia Tibet, 1894, p. 370.

DIMENSIONS

	mm.
Tip of snout to vent	47
Length of head	16
Width of head	22
Snout	6
Eye	6
Width between nostrils	4.5
Interorbital width	4
Width of upper eyelid	4.7
Tympanum	3.5
Foreleg	24
First finger	5.5
Second finger	4.5
Third finger	7.5
Fourth finger	5
Hind leg	73
Tibia	24.5
Width of tibia	22.5
Foot	22.5
First toe, from metatarsal tubercle	6
Inner metatarsal tubercle	3.7
Fifth toe shorter than third	6.8
Fifth toe shorter than fourth	2

RANA EMELJANOVI Nikolski

1913. *Rana emeljanovi* NIKOLSKI, Ann. Zool. Mus. St. Pétersbourg, vol. 18, 1913, p. 148 (type locality, Ilialpo,[21] Manchuria; type in Mus. Univers. Kharkof; Dr. Emeljanof, collector).

1918. *Rana emeljanowi* NIKOLSKI, Fauna Rossij, Amph., p. 83, pl. 2, fig. 2, (Iliampo).

Mr. Sowerby collected three good specimens of this interesting species on the north bank of Yalu River, the boundary between Manchuria and Korea, about 180 miles from its mouth. It is closely related to the Japanese *Rana rugosa* as noted by the original describer.

RANA SPINOSA David

1858. *Rana kuhlii* GUENTHER, Cat. Batr. Sal. Brit. Mus., p. 8 (part: Ningpo); Rept. Brit. India, 1864, p. 404 (part) pl. 26, fig. A (Ningpo).

1872. *Rana latrans* DAVID, Nouv. Arch. Mus. Hist. Nat. Paris, vol. 8, Bull., p. 85 (type locality "Cascades de Kiangsi") (not of Steffen, 1815).

1875. *Rana spinosa* DAVID, Journ. Trois. Voy. Chinois, vol. 2, p. 253 (type locality, Ouang-mao-tsae, prov. Kiangsi).—BOULENGER, Rec. Indian Mus., vol. 20, 1920, p. 74 (China south of the Yangtse Kiang).—SMITH, Rec. Indian Mus., vol. 26, March 1924, p. 137 (tadpoles; peak at Hongkong).

1889. *Rana boulengeri* GUENTHER, Ann. Mag. Nat. Hist., ser. 6, vol. 4, September. 1889, p. 222 (type locality, Ichang, Hupeh; cotypes in Brit. Mus.: A. E. Pratt, collector); in Pratt's To Snows of Tibet, 1892, p. 243 (Ichang).—BOULENGER, Proc. Zool. Soc. London, 1899, p. 166 (Kuatun, Fukien).

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[21] So written in the original description. In his Fauna Rossij, Amph., 1918, Nikolski twice spells it Iliampo. It is said to be a station on the East Chinese Railroad, but I have been unable to locate it. I have only found a station Imenpo on the road between Harbin and Vladivostok.

A splendid series of ten adults (U. S. Nat. Mus. Nos. 64884–93) of this very large frog was collected during the late autumn of 1921 by Sowerby in the upper Min River basin, at an altitude of about 5,000 feet, consequently not far from the type locality of the species. Three equally large specimens (Nos. 64647–9) collected by C. R. Kellogg on August 10 of the same year supplement the above and give a good demonstration of the variability of this species. The more variable parts seem to be the interorbital width and the relative distance of the nostrils between the eye and the tip of the snout, but with the looseness of the skin it is very difficult to give exact measurements which are of value to others than the one taking them.

The males have the breast studded with white semiglobular tubercles, which in most of them are surmounted by a black conical spine. Similar spiny tubercles closely crowded together form pads at the tip of the inner metacarpal tubercle, which is enormously developed, the upper and inner sides of first and second fingers and inner side of third finger. The largest specimen, a male (No. 64884), measures 115 mm. in total length from tip of snout to vent.

The observations made by Mr. Sowerby on the habits of this species coincide with those recorded by Père David, who discovered the species in the high mountains dividing the province of Kiangsi from Fukien. In his letter of January 27, 1922, Mr. Sowerby writes that "The large frogs were taken amongst the rocks in the stream beds at an altitude of 5,000 feet," and that "they are considered a great delicacy by the Chinese." Mr. Kellogg, writing from Foochow, adds that "they seem fairly common, as I have seen large numbers of them for sale at different times, though they are rare enough to bring a better price in the markets than the common frogs."

Besides the above large specimens, Mr. Sowerby sent a very young one (No. 65249), which he collected at Yenpingfu, Fukien, and which I refer to this species with but little doubt. It is only 26 mm. long, but it has already a very strongly developed inner metacarpal tubercle; in addition the distance between eye and nostril is very short, so that I do not think it can be referred to *R. kuhlii*.

RANA LIMNOCHARIS Gravenhorst

To the synonymy as given in Herpetology of Japan, 1907, p. 127, add:

1829. *Rana limnocharis* "Kuhl" GRAVENHORST, Delic. Mus. Zool. Vratislav., fasc. 1, p. 42 (type locality, Java; type in Mus. Breslau; Kuhl, collector).—WIEGMANN, Nova Acta Acad. Leop. Carol., vol. 17, pt. 1, p. 255 (Java).—BOETTGER, Kat. Batr. Mus. Senckenberg., 1892, p. 3 (Hongkong; Shanghai; Canton; Hankow); Ber. Senckenberg. Naturf. Ges., 1894, p. 137 (Hongkong): p. 138 (Hankow); p. 144 (Shanghai).—WERNER, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, pp. 358, 308 (Shanghai; Hankow).—WOLTERSTORFF, Abh. Mus. Madgeburg, vol. 1,

1906, p. 130 (Kowloon, near Hongkong; Foochow; Pingsiang, Kiangsi; Nimrod Sound, Chekiang; Kiukiang; Nanking; Tsingtao, Shantung).—BOULENGER, Vert. Malay Penins., Rept. Batr., 1912, p. 236 (India, China, Japan, Malay Pen. and Archip.); Rec. Indian Mus., vol. 20, 1920, p. 28 (eastern Asia).—ANNANDALE, Mem. Asiat. Soc. Bengal, vol. 6, 1917, p. 132 (China, Borneo, Java).—GEE, Journ. N. China Asiat. Soc., vol. 50, 1919, p. 184 (Soochow).

Rana gracilis STEINDACHNER, Reise Novara, Zool., vol. 1, Amph., 1862, p. 18 (Shanghai, Hongkong).—GUENTHER, Ann. Mus. Zool. St. Pétersbourg, vol. 1, 1896, p. 206 (Yachow, Szechwan).

In his Monograph, 1920 (pp. 28 and 29), Boulenger has pointed out two errors in my treatment of this species in the Herpetology of Japan, to which I plead guilty. The first is in regard to its relationship to *R. tigerina*, which I had questioned. The second relates to a slip—to me utterly unexplainable—in the description of the female from Japan, about which I said (p. 128) that the tibiotarsal articulations "only touch without overlapping." I have reexamined the specimen (U. S. Nat. Mus. No. 31798) and find that the heels "overlap considerably." This is also correctly stated in the "Key," as pointed out by Boulenger. Holders of the "Herpetology" are requested to make the correction in their copy.

The National Museum has now splendid series of this species, both from Java, the type-locality, and from China and Japan. It shows a surprising individual variability, and I have been unable to find any tangible differences which would justify splitting up our material into geographical groups. L. I. Moffett has sent us specimens (Nos. 52573–5, 52583, 52587) from Kiangyin, Kiangsu; Prof. C. Ping (No. 66847) from Nanking; E. Deschamps (Nos. 31724–56) and Sowerby from Shanghai (Nos. 65229–35, 65247, 66355–76). The latter also collected it at Hangchow, Chekiang (No. 66464) and found it numerous in Fukien, at Foochow (Nos. 65310–26, 66429), at Futsing (Nos. 65259–65), near Yenping (Nos. 65271–88), and even in the upper Min Basin (Nos. 64880–3). Graham collected a fine lot at Suifu (Nos. 65813–4, 65923, 65928–30, 65938–40), and also three specimens from Mount Omei (Nos. 64424 and 65812, Shin-Kai-Si, altitude 4,400 feet) and a large female (No. 65468), total length 48 mm., thus corroborating Potanin's find of this frog at Yachow in 1894.

RANA RUGULOSA Wiegmann

1835. *Rana rugulosa* WIEGMANN, Nova Acta Acad. Leop. Carol., vol. 17, pt. 1, p. 258, pl. 21, fig. 2 (type locality, Cape Syng-more, China; type, No. 3721, Berlin Mus.; Meyen, collector).—FITZINGER, Sitz. Ber. Akad. Wiss. Wien, Math. Nat. Kl., vol. 42, 1861, p. 414 (Shanghai, Hongkong).—PETERS, Mon. Ber. Akad. Wiss. Berlin, 1863, p. 78 (type).—ANNANDALE, Mem. Asiat. Soc. Bengal, vol. 6, 1917, p. 126 (Burma, Siam, South China, Formosa); Rec. Indian Mus., vol. 15, April, 1918, p. 60 (Burma, Siam, China).

1835. *Rana vittigera* WIEGMANN, Nova Acta Acad. Leop. Carol., vol. 17, pt. 1, p. 255 (part: specimens from Macao, China, Berlin Mus. No. 3270).

1856. *Rana rugosa* LICHTENSTEIN and MARTENS, Nomencl. Amph. Mus. Berol., p. 38 (China) (not of Schlegel).

1860. *Rana tigrina* HALLOWELL, Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 504 (Hongkong) (not of Daudin).—STEINDACHNER, Reise Novara, Zool., vol. 1, Amph., 1862, p. 17 (part: Hongkong).—BOULENGER, Cat. Batr. Sal. Brit. Mus., 1882, p. 26 (part: Shanghai, Ningpo; Formosa).—BOETTGER, Offenbach. Ver. Naturk., 24–25 Ber., 1885, p. 130 (Canton): Kat. Batr. Mus. Senckenberg. Naturf. Ges., 1894, p. 137 (Hongkong).—PARENTI and PICAGLIA, Atti Soc. Natur. Modena, Mem. (3), vol. 5, 1886, p. 90 (Hongkong market).—WERNER, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p. 358 (Shanghai).—WOLTERSTORFF, Abh. Mus. Magdeburg, vol. 1, 1906, p. 130 (Pingshang, Kiangsi; Canton; Kiukiang; Shanghai).—GEE, Journ. N. China Asiat. Soc., vol. 50, 1919, p. 184 (Soochow).

1861. *Hydrostentor pantherinus* FITZINGER, Sitz. Ber. Akad. Wiss. Wien, Math. Nat. Kl., vol. 42, p. 414 (nomen nudum).

1862. *Rana tigrina*, var. *pantherina* STEINDACHNER, Reise Novara, Zool., vol. 1, Amph., pl. 1, figs. 14–17 (Hongkong).—BOULENGER, Rec. Indian Mus., vol. 20, 1920, p. 21 (Burma, Siam, French Indo-China, China, and Formosa).

1907. *Rana tigerina* STEJNEGER, Herp. Japan, Bull. U. S. Nat. Mus. No. 58, p. 139 (part: Hongkong; Formosa); Proc. U. S. Nat. Mus., vol. 38, 1910, p. 96 (Formosa).—BARBOUR, Mem. Mus. Comp. Zoöl., vol. 40, No. 4, 1912, p. 128 (Ichang, Hupeh).

1910. *Rana burkilli* ANNANDALE, Rec. Indian Mus., vol. 5 (p. 79) (type-locality, Tavoy, Tenasserim; type, in Calcutta Mus.).

1918. *Rana tigrina*, var. *burkilli* BOULENGER, Rec. Indian Mus., vol. 15, April, 1918, p. 58 (Burma, Siam, China).

Thanks to the painstaking investigations of Annandale and Boulenger, the several species or subspecies clustering around the old *Rana tigerina*, their geographical distribution and nomenclature, have now been fairly well cleared up. The synonymy of the form occurring in China has therefore been rewritten as above and should supersede that of the Herpetology of Japan (p. 139).

In addition to the old specimens from Hongkong, the National Museum now possesses the following from the Chinese mainland: Nos. 46616, from Shanghai, collected by D. C. Jansen; three from Shanghai (Nos. 66348–50); 33 from Foochow, Fukien, by Sowerby (Nos. 65334–6; 66377–85; 66406–26); and one from Wenchow, Chekiang, by Prof. C. Ping (No. 66846).

Genus POLYPEDATES Tschudi

The name *Rhacophorus* has recently been resuscitated for this genus on the strength of a passage in a letter by Kuhl and van Hasselt, in the Algemeene Konst- en Letter-Bode (Haarlem) 1822, pt. 1, p. 104. This, however, is the original of the reference in German translation [22] to which I called attention in the Herpetology

[22] Isis, 1822, p. 476.

of Japan, 1907 (p. 144), and alters in no way the fact that the two species mentioned are absolute *nomina nuda* and that the character mentioned fitted no other "Hyla" then known than *Hyla palmata* Daudin. The first reference of the generic name *Rhacophorus* by Schlegel, in 1827, to any described species, as well as the subsequent action of Wagler[23] and van der Hoeven[24] undoubtedly ties the name to *H. palmata* as a synonym of *Hyla*. The first species belonging to this genus, as now understood, was not given a nomenclatorial status until after 1838.

POLYPEDATES LEUCOMYSTAX MEGACEPHALUS (Hallowell)

1858. *Polypedates maculatus* GUENTHER, Cat. Batr. Sal. Brit. Mus., p. 78 (part: Hongkong, China; not of Gray).—MUELLER, Verh. Naturf. Ges. Basel, vol. 6, pt. 4, 1878, p. 585 (Lilong and Fumun, Kwantung).—*Rhacophorus maculatus* BOULENGER, Cat. Batr. Sal. Brit. Mus., 1882, p. 83 (part).—BOETTGER, Offenbach. Ver. Naturk., 24–25 Ber., 1885, p. 131 (Swatow); 26–28 Ber., 1888 (pp. 97, 160).

1860. *Polypedates megacephalus* HALLOWELL, Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 507 (type-locality, Hongkong, China).

1878. *Polypedates maculatus*, var. *unicolor* MUELLER, Verh. Naturf. Ges. Basel, vol. 6, pt. 4, 1878, p. 585 (type-locality, China; type in Basel Mus.).

1889. *Rhacophorus leucomystax* BOULENGER. Proc. Zool. Soc. London, 1889, p. 29 (part; not of Gravenhorst); 1899, p. 169 (Kuatun, Fukien).—BOETTGER, Kat. Batr. Mus. Senckenberg., 1894, p. 137 (Hongkong).—WERNER, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p. 369.—WOLSTERSTORFF, Abh. Mus. Magdeburg, vol. 1, 1906, p. 125 (Kowlung Mt., Hongkong); p. 126 (Canton).—VOGT, Sitz. Ber. Ges. Naturf. Freunde, Berlin, 1914, p. 101 (Kwantung).—GEE, Journ. N. China Asiat. Soc., vol. 50, 1919 (p. 148) (Soochow).—*Polypedates leucomystax* STEJNEGER, Herpet. Japan, Bull. U. S. Nat. Mus., No. 58, 1907, p. 157 (Formosa).—VAN DENBURGH, Proc. California Acad. Sci., ser. 4, vol. 3, Dec. 16, 1912, p. 206 (Formosa).

1911. *Rhacophorus braueri* VOGT, Sitz. Ber. Ges. Naturf. Freunde, Berlin, 1911, p. 180 (type-locality, Formosa; type in Berlin Mus.).

A single specimen, collected by Sowerby at Foochow (No. 66405) is so darkened and shriveled that nothing much can be said about its identity, except that it belongs to *P. leucomystax* in the wider sense. One color feature can be made out distinctly, namely the coarse dark reticulation on the posterior aspect of the whitish femur remarked upon by Boulenger[25] as present in the other Fukien specimen and also noticed by Boettger[26] on a specimen from Swatow and by Van Denbrugh in Formosan specimens.[27] In combination

[23] Syst. Amph., 1830, p. 200 and Isis, 1833.
[24] Handb. Dierk., vol. 2, pt. 2, 1833, p. 311.
[25] Proc. Zool. Soc. London, 1889, p. 169.
[26] Offenbach. Ver. Naturk., 24–25 Ber., 1885, p. 131.
[27] Proc. California Acad. Sci., ser. 4, vol. 3, Dec. 16, 1912, p. 206.

with the peculiarity of the Chinese specimens that the skin is not involved in the cranial ossification, it may indicate a recognizable form deserving of a separate name for which Hallowell's *megacephalus* is available. In this connection I may call attention to Vogt's *Rhacophorus braueri*[28] from Formosa, which evidently belongs to this group. The National Museum possesses a specimen from Kosempo, Formosa, which in every particular fits Vogt's description. This I cannot separate structurally from Sowerby's Fukien specimen, and the reticulation on the hind part of the femur is identical. Vogt has since (1914) recognized *R. braueri* as belonging to *R. leucomystax*.[29]

DIMENSIONS

	mm.
Tip of snout to vent	42
Width of head	15
Interorbital space	5.5
Upper eyelid	3.5?
Distance from nostril to eye	4.5
Diameter of eye	4.5?
Diameter of tympanum	3
Width of largest finger disk	1.5?
Fore leg	26
Hind leg, vent to tip of longest toe	68
Tibia	22

POLYPEDATES DENNYSI[30] (Blanford)

1881. *Rhacophorus dennysi* BLANFORD, Proc. Zool. Soc. London, 1881, p. 224, pl. 21, figs. 3–3*a* (type locality, China; type in Raffles Mus., Singapore).—BOETTGER, Offenbach. Ver. Naturk., 24–25 Ber., 1885, p. 161 (China).

1882. *Rhacophorus dennysii* BOULENGER, Cat. Batr. Sal. Brit. Mus., p. 87 (China?); Proc. Zool. Soc. London, 1899, p. 169 (Foochow and Kuatun, Fukien).—VOGT, Sitz. Ber. Ges. Naturf. Freunde, Berlin, 1914, p. 101 (Kwantung).—WOLTERSTORFF, Abh. Mus. Magdeburg, vol. 1, 1906, p. 126 (Pingsiang, Kiang-si).

Both Mr. Sowerby and Prof. Claude R. Kellogg have sent us this gigantic and handsome frog from Fukien. Sowerby's series (Nos. 65197–215, 65268–70) are from near Yenpingfu, while Kellogg's was taken "within 200 miles of Foochow."

POLYPEDATES OMEIMONTIS Stejneger

1924. *Polypedates omeimontis* STEJNEGER, Occ. Pap. Boston Soc. Nat. Hist., vol. 5, July 21, 1924, p. 120 (type-locality, Shin-Kai-Si, Mt. Omei, Szeshwan; type U.S.N.M. No. 66548; Rev. D. C. Graham, collector).

Diagnosis.—Fingers half-webbed; head without spines; no cutaneous folds along legs; no dermal flap at heel; vomerine teeth in

[28] Sitz. Ber. Ges. Naturf. Freunde, Berlin, 1911, p. 180.

[29] Idem, 1914, p. 101.

[30] Named for Dr. N. B. Dennis who discovered the type specimen alive at a Chinese merchant's house in Singapore. When it died it was presented to the Raffles Museum. It was said to have originally come from China.

two slightly oblique series between the choanae; tympanum distinct, more than half the width of eye; upper and lower surfaces, except of hands and feet, granular; interorbital space slightly broader than upper eyelid; largest digital disk nearly as large as tympanum; tibio-tarsal joint reaching posterior angle of eye.

Description of type specimen.—Vomerine teeth in two slightly oblique series between and close to the choanae, each longer than the distance between them; profile of snout abruptly declivous, almost angular, from the nostrils; canthus rostralis sharp overhanging the concave loreal region as a ridge; nostrils prominent, slightly nearer the eye than the tip of the snout; interorbital space wider than upper eyelid; tympanum smooth, almost circular, about two-thirds the diameter of the eye; fingers with well-developed dermal edges, webbed one-half between third and fourth fingers, the web reaching almost to the penultimate joints of both; between second and third about one-third, reaching penultimate joint of second, but only basal joint of third; between first and second only at the base; disks of fingers very large, that of third finger nearly as large as tympanum, that of first finger but slightly wider than finger itself; first finger much shorter than and hardly reaching the middle of the penultimate joint of the second; toes more than two-thirds webbed, the web reaching the tip of the three inner toes; fifth toes longer than third by about half the diameter of the disk; disks of toes scarcely two-thirds the diameter of the finger disks; subarticular articulations moderately prominent; inner metatarsal tubercle small, flat, no outer metatarsal tubercle; tibio-tarsal joints reach posterior angle of eye and meet without overlapping when hind legs are placed vertical to the axis of the body; a sharp, narrow dermal fold from eye over tympanum to shoulder; skin above and below, except hands and feet densely granulated, the granules rather roughly tubercular on the upper surfaces, rounded underneath.

Color (in alcohol): Above purplish brown with indistinct and irregular dusky markings and indication of cross bars on the legs; underside whitish with small blackish spots on inner sides of arms, thigh, tibia, and hind feet; sides whitish with blackish spots and marblings which become coarser and more distinct posteriorly; lips with indistinct dusky spots; at the base of the upper surface of first and second fingers a very distinct white spot.

DIMENSIONS

	mm.
Tip of snout to vent	63
Width of head	21
Tip of snout to nostril	5.5
Nostril to eye	5
Interorbital space	7

	mm.
Upper eyelid	6
Diameter of eye	7
Diameter of tympanum	4.5
Diameter of largest finger disk	4.3
Fore leg	44
Hind leg, vent to tip of longest toe	95
Tibia	30

Genus OXYDOZYGA Tschudi

1838. *Oxyglossus* Tschudi, Mém. Soc. Sci. Nat. Neuchâtel, vol. 2, p. 85 (monotype, *O. lima* Tschudi) (not of Swainson, 1828).

1838. *Oxydozyga* "Kuhl" in "Tschudi, Mém. Soc. Sci. Nat. Neuchâtel, vol. 2, p. 85 (in synonymy of *Oxyglossus;* type *O. lima*).

1867. *Phrynoglossus* Peters, Mon. Ber. Berlin Akad. Wiss., 1867, p. 29 (type *P. martensii* Peters).

1877. *Microdiscopus* Peters, Mon. Ber. Berlin Akad. Wiss., 1877, p. 421 (type *M. sumatranus* Peters).

1916. *Oxyglossis* Smith, Journ. Nat. Hist. Soc. Siam, vol. 2, Dec. 1916, p. 172 (err. typogr.).

Unfortunately the well known genus name *Oxyglossus* of Tschudi for this genus has to give way, as it was applied by Swainson ten years earlier to a genus of birds.[31] However, Tschudi himself furnished a substitute name of the same date by citing Kuhl's manuscript name for the same material upon which Tschudi based his genus and species.

OXYDOZYGA LIMA (Gravenhorst)

1829. *Rana lima* Gravenhorst, Delic. Mus. Zool. Vratislav., pt. 1, p. 41 (type-locality, Java; type in Mus. Leiden; Kuhl, collector).

Oxyglossus lima Tschudi, Mém. Soc. Sci. Nat. Neuchâtel, vol. 2, 1838, p. 85 (Java).—Hallowell, Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 506 (Hongkong).—Guenther, Rept. Brit. India, 1864, p. 401 (China, Java, Siam, Cambodia).—Boulenger, Cat. Batr. Sal. Brit. Mus., 1882, p. 5 (Java to South China).—Boettger, Offenbach. Ver. Naturk., 24–25 Ber., 1885, p. 158 (Prov. Canton): Ber. Senckenberg. Naturf. Ges., 1887–88, p. —; Kat. Batr. Mus. Senckenberg, 1892, p. 1 (Canton, Mt. Lo-fu-shan, Kwangtung).—Werner, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p. 368.—Vogt, Sitz. Ber. Ges. Naturf. Freunde, Berlin, 1914, p. 100 (Kwangtung).

1838. *Oxydozyga braccata* "Kuhl" in Tschudi, Mém. Soc. Sci. Nat. Neuchâtel, vol. 2, p. 85 (in synonymy of *Oxyglossus lima*).

1878. *Oxyglossa lima* var. *chinens*[*is*] Mueller, Verh. Naturf. Ges. Basel, vol. 6, pt. 4, p. 580 (nomen nudum) (Lilong, prov. Kwangtung).

A single young specimen (No. 65257) taken by Sowerby at Futsing, is the first record of this species in Fukien. Originally de-

[31] Zool. Journ., vol. 3, 1828, p. 356.

scribed from Java, the species extends to Bengal and southern China. Hallowell recorded it from Hongkong; Mueller from Lilong, and Boettger from Canton and Mount Lofu-shan, all in the province of Kwangtung. The National Museum has it from Canton and Hongkong. I have compared these Chinese specimens with material from Java and the Malay Peninsula in our collection and find no characters to distinguish them, a remark perhaps not superfluous in view of the fact that Mueller recorded his Lilong specimen as *O. lima* var. *chinensis*.

Class REPTILIA

Order LORICATA

Family CROCODYLIDAE

Genus ALLIGATOR Cuvier

1807. *Alligator* CUVIER, Ann. Mus. Hist. Nat. Paris, vol. 10, p. 25 (type, *A. lucius*=*Lacerta alligator* BLUMENBACH, part).

ALLIGATOR SINENSIS Fauvel

1879. *Alligator sinensis* FAUVEL, Journ. N. China Asiat. Soc., new series, vol. 13, p. 34, pl. (type locality, Wahu; type in Shanghai Mus.; J. L. E. Palm, collector).—VAILLANT, Ann. Sci. Nat., ser. 6, Zool., vol. 9, 1880, art. no. 8, p. 1 (China).—BOETTGER, Offenbach. Ver. Naturk., 24–25 Ber., 1885, p. 137 (Central China); 26–28 Ber., 1888 (p. 111); Ber. Senckenberg. Naturf. Ges., 1894, p. 142 (Wuhu, Anhwei.—BOULENGER, Cat. Chel. Brit. Mus., 1889, p. 291 (Yangtse-Kiang); Proc. Zool. Soc. London, 1890, p. 619, pls. 51–52 (Kiukiang).—GUENTHER, Ann. Mag. Nat. Hist., ser. 6, vol. 4, Sept. 1889, p. 219 (Kiukiang).—WERNER, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p. 360.—BARBOUR, Proc. Acad. Nat. Sci., Philadelphia, 1910, p. 464 (Yangtse River). Proc. New England Zoöl. Club, vol. 8, Sept. 1922, p. 32 (Wuhu).—STANLEY, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 22 (Wuhu); vol. 49, 1818, p. xiv (Wuhu).—GEE, Journ. N. China Asiat. Soc., vol. 50, 1919, p. 184 (Soochow).

Alligator sinense MOOK, Bull. Amer. Mus. Nat. Hist., vol. 48, Dec. 7, 1923, p. 553 (lapsus) (skull).

Two skins (Nos. 52557–58), 1,320 and 1,030 meters long, respectively, have been received from L. I. Moffett. They were collected near Huchow in the province of Chekiang. Both agree closely with the beautiful figure of the head and neck of the specimen in British Museum, accompanying Boulenger's paper of 1890, except that there are three scutes on each side of the occipital series. Both have three pairs of nuchal scutes, six scutes in the fifth transversal dorsal row, and 34 caudal whorls.

Order SQUAMATA

Suborder SAURIA

Family GEKKONIDAE

GEKKO SUBPALMATUS Guenther

1864. *Gecko subpalmatus* GUENTHER, Rept. Brit. India. p. 104, pl. 12, fig. *B* (type locality, Chikiang, China; type in Brit. Mus.; Fortune, collector).—BOULENGER, Cat. Liz. Brit. Mus., vol. 1, 1885, p. 189 (Chikiang); Proc. Zool. Soc. London, 1899, p. 160 (Kuatun, prov. Fukien).—BOETTGER, Offenbach. Ver. Naturk., 24–25 Ber., 1885, p. 139 (Chikiang).

After a careful examination of a considerable material consisting of 49 specimens of Gekko from China, besides numerous ones from Japan, Riukiu, Tsu-shima, and Korea, I have come to the conclusion that Guenther and Boulenger were right in recognizing three different forms. The characters which separate them are very variable, and it may take a combination of two or more to decide in doubtful cases, but with one exception I have been able to place all the specimen before me to my entire satisfaction. The three forms are only geographic subspecies, it is true, and in some intermediate localities there may be more real intergradation than my material shows, but, on the other hand, I have a strong suspicion that some of the intergradation may be due to hybridization. These lizards are easily carried about accidentally in cargoes, and the enormous extent of the territory covered by the coast form, *G. japonicus*, from Hongkong to the Gulf of Tartary, Formosa, and Japan, is probably due to such accidental dispersion. It is also significant that it is this form which occurs along the Yangtse River as far inland as Ichang at least. It can scarcely be doubted that individuals thus carried into the territory of a form so closely allied, as these geckos manifestly are, would eventually mix with it, probably resulting in specimens which obscure the diagnostic character of the subspecies.

Rev. D. C. Graham has sent five specimens of *G. subpalmatus* from Suifu. They are all practically devoid of tubercles, and the web at the base of the toes is well developed and is an easily recognized character. The size and shape of the median chin shields is not so reliable. In one old female, No. 63593, they are not differentiated at all, but in the others they are well marked though considerably smaller than in the average *G. japonicus*, and similar to those of most *G. swinhonis*.

The type locality of this form, Chikiang, is apparently also located in Szechwan, and as far as I know no specimens from outside that province have as yet been recorded, except the female collected by La Touche in 1896 at Kuatun, province Fukien, as noted by Bou-

lenger. Among Sowerby's Fukien material there is also a gecko collected by him at Foochow. As far as the web of the feet is concerned, it is a typical *G. subpalmatus*, but the back is regularly covered with small though distinct tubercles, and the median chin shields are rather well developed. As Boulenger in recording the La Touche specimen gave no details, I wrote to Miss Joan B. Procter asking her to examine it with regard to the above points. She kindly replied that the dorsal skin is uniformly granular without any of the tubercles proper to *G. japonicus*, that it also has a well-defined interdigital web and small chin shields, and is in every way the typical *G. subpalmatus*. I am therefore strongly inclined to the belief that the tubercles of the Sowerby specimen are the result of admixture of *G. japonicus* blood, especially as Foochow is a seaport, while the Kuatun locality is a considerable distance inland.

GEKKO SWINHONIS Guenther

For synonymy see Stejneger, Herpetology of Japan, 1907, p. 166, footnote. Add:

Gecko swinhoei WERNER, Abh. Bayer. Akad. Wiss., II Kl., 1903, p. 360 (Tientsin).

Gekko swinhonis BARBOUR, Proc. New England Zoöl. Club, vol. 4, Nov. 1909, p. 61 (Sian, Shensi).—VAN DENBURGH, Proc. California Acad. Sci., ser. 4, vol. 3, Dec. 16, 1912, p. 207 (Chefu).

Gecko japonicus SOWERBY in Clark and Sowerby, Through Shen-Kan, 1912, p. 111 (Kansu, Shensi).

Mr. Sowerby collected five specimens at Pei-tai-ho in northeastern Chili, on the north side of the Gulf of Pechili, during August, 1921 (Nos. 64875–79). They are perfectly typical of this form with small and few tubercles, hardly any in front of the shoulders. In some there are a few tubercles on the temples, but the amount and size of the temporal tubercles do not seem to be of any diagnostic importance. The chin shields vary to some extent, being mostly of median size, in one specimen rather large, in two rather small.

Three specimens (Nos. 39343–45) collected by him in Kansu, 20 miles west of Chingyangfu, on August 7, 1909, are likewise referable to this subspecies.

A young specimen (No. 39342) collected by him 20 days later at Ching-chien-hsien, Shensi, is somewhat dubious in its relationships. The tubercles are rather well developed and numerous on the back as well as on upper neck and on the temples, though there are none on the occiput. On the other hand, the chin shields are small, separated by a small median one, much as in extreme *G. swinhonis*. I can discover no trace of a web. Have we here to do with an admixture of *G. japonicus* blood accounting for the great development of the tubercles? I am the more inclined to think so since Doctor Barbour, in recording five specimens from Sian, or Sigan (Hsi-ngan),

in the southern part of Shensi, of which it is the capital, states that they substantiate the characters of few dorsal tubercles and a small, separated inner pair of chin shields.

A specimen of the same age (No. 35528) which, if the label is read correctly, is from Hwo-ma-wan, Shantung, collected by Prof. E. Blackwelder on November 12, 1903 (collector's number 6016), has very few tubercles and small, separated chin shields, and is an undoubted *G. swinhonis*.

This brings up the question as to the status of the Chefu specimens. Doctor Van Denburgh refers them to *G. swinhonis*, but Boulenger, who recognized the distinction of the latter, refers a specimen in British Museum to *G. japonicus*. Have we here a case of a recent accidental introduction of the latter?

In adition to the above material the National Museum has a fine large series of 26 typical specimens of *G. swinhonis* from the country between Tien-tsin and Peking, collected by M. L. Robb (Nos. 29702–27) which illustrates beautifully the extent of the individual variation in this form.

GEKKO JAPONICUS (Duméril and Bibron)

For synonymy see Stejneger, Herpetology of Japan, 1907, pp. 165–166. Add:

Gecko japonicus BOULENGER, Cat. Liz. Brit. Mus., vol. 3, 1887, p. 488 (Ichang, China; Riukiu Islands).—BOETTGER, Offenbach. Ver. Naturk., 24–25 Ber., 1885, p. 139 (China); Ber. Senckenberg. Naturf. Ges., 1894, p. 143 (Shanghai).—GUENTHER, in Pratt's To Snows of Tibet, 1892, p. 239 (Mountains north of Kiukiang).—WERNER, Abh. Bayer. Akad. Wiss., II Kl., 1903, p. 360 (China).

Gekko japonicus BARBOUR, Proc. New England Zoöl. Club, vol. 4, Nov., 1909, p. 61 (Kanagawa, Japan).—VAN DENBURGH, Proc. California Acad. Sci., Nov. 4, vol. 3, Dec. 16, 1912, p. 106 (Shanghai; Formosa; Riukiu Islands).

The question of the relationship of this form has been discussed above, and it has also been intimated that it may have been widely dispersed in China, including the Yangtse Valley, by human agency. The specimens sent by L. I. Moffett from Kiangyin, Kiangsu (Nos. 52561–5); by F. N. Meyer from Hankow (No. 60049); by Dr. Lewis R. Thompson from the southwestern part of Hunan (Nos. 63204–5); and by J. T. Illick from Kiangsu (No. 65093) are plainly referable to this form.

HEMIDACTYLUS BOWRINGII (Gray)

For synonymy and illustration see Herp. Japan, 1907, p. 176 to which add: VOGT, Sitz. Ber. Ges. Naturf. Freunde, Berlin, 1914, p. 79 (South China [Canton?]).

Eight specimens (Nos. 66446–53) recently received from Mr. Sowerby attest to the occurrence of this species at Foochow, Fukien, six adults and two young. The two adult males have each 15 pores on each femur.

Family AGAMIDAE

JAPALURA FLAVICEPS Barbour and Dunn

1896. *Japalura yunnanensis* GUENTHER, Ann. Mus. Zool. Acad. Sci. St. Pétersbourg, vol. 1, p. 203 (Riv. Tung, Szechwan) (not of Anderson).—BARBOUR, Mem. Mus. Comp. Zoöl., vol. 40, no. 4, August, 1912, p. 134 (Tung River, Szechwan).

1919. *Japalura flaviceps* BARBOUR and DUNN, Proc. New England Zoöl. Club, vol. 7, Oct. 10, 1919, p. 16 (type-locality, Shores of Tung River, western Szechwan; type, Mus. Comp. Zoöl., no. 12469; W. R. Zappey, collector).

This species which is considerably smaller and less conspicuously marked than *J. splendida* appears to be confined to the higher altitudes of western Szechwan and Yunnan. Until recently, when Barbour and Dunn separated the three species, both were confounded with *J. yunnanensis.* There is consequently doubt yet as to the pertinency of some of the older records. Thus, while there is no doubt that the *Japalura* collected by Potanin on the Tung River belongs here, as practically from the type-locality, there is no such certainty as to the specimen collected by Berezowski at Lunganfu, Szechwan, both of which were recorded by Guenther, in 1896, as *J. yunnanensis.* This doubt is now set at rest by the receipt of a splendid series collected by Mr. Graham at Mowchow at an altitude of 5000 feet (Nos. 67820–7) and at Wanchow (Nos. 67776–7).

Rev. D. C. Graham collected eleven good specimens representing both sexes and young on his trip to Tatsienlu, consequently not far from the type locality. Six (Nos. 66536–41) were from within 30–40 miles of Tatsienlu, and five (Nos. 66637–41) from Lu-ding-chiao on the Tung River, all at altitudes ranging between 4,500 and 6,000 feet.

JAPALURA SPLENDIDA Barbour and Dunn

1870. *Japalura swinhoii* SWINHOE, Proc. Zool. Soc. London, 1870, p. 411 (Chunkingfu, Szechwan) (not *J. swinhonis* GUENTHER).

1885. *Japalura yunnanensis* BOULENGER, Cat. Liz. Brit. Mus., vol. 1, p. 310 (Szechwan) (not of Anderson).—GUENTHER, Ann. Mag. Nat. Hist. (ser. 6), vol. 4, 1889, p. 218 (*yunnansis*, err. typ.) (Ichang); in Pratt's To Snows of Tibet, 1892, p. 239 (Ichang).—STEJNEGER, Herp. Japan, p. 187 (Chinling Mountains, Shensi).

1919. *Japalura splendida* BARBOUR and DUNN, Proc. New England Zoöl. Club, vol. 7, Oct. 10, 1919, p. 18 (type locality, Gorge of the Yangtse River near Ichang, Hupeh; type, U. S. Nat. Mus. No. 35522; E. Blackwelder, collector).

In addition to the material upon which Barbour and Dunn founded the species, namely, the type No. 35522, from the gorge of the Yangtse near Ichang, the paratypes No. 35523, from near Taninghsien at the eastern end of the Chihsiting Pass, eastern Szechwan near the Hupeh border, and No. 35524 from Liang-ho, Chinling Mountains, southern Shensi, all collected by Prof. E. Blackwelder in 1904, the Museum has now a fine series of six elegant

specimens (Nos. 65461–6) collected by Rev. D. C. Graham near Mount Wa, Szechwan. The largest is as large as the type, even more brightly colored and with a much higher and better developed nuchal crest, which in the original description of the type is characterized as "very feeble."

Genus PHOXOPHRYS Hubrecht

1881. *Phoxophrys* Hubrecht, Notes Leyden Mus., vol. 3 (p. 51) (monotype *Ph. tuberculata* Hubrecht).

PHOXOPHRYS GRAHAMI Stejneger

1924. *Phoxophrys grahami* Stejneger, Occ. Pap. Boston. Soc. Nat. Hist., vol. 5, July 21, 1924, p. 120 (type-locality, Suifu, Szechwan, China; type, U.S.N.M. No. 65500; Rev. D. C. Graham, collector).

Diagnosis.—All scales keeled; anterior superciliaries not enlarged into horn-like appendages; supralabials eight; flanks with numerous large scales equal to the largest on the back.

Description of type.—Adult: Rostral low, about four times as wide as high, separated from nasal by one scale; nostril circular, with a swollen rim, in the posterior part of a rather large, oblong scale which is situated below the rostral canthus and in contact with first supralabial; canthus rostralis very sharp, covered with small angular scales forming a ridge continuous with a high superciliary crest, the last two scales of which are enlarged and angularly compressed, above and behind center of eye; top of head, including supraoculars, covered with unicarinate, more or less wrinkled scale of varying size; snout and interorbital space deeply concave, the later covered with one or two scales between the supraorbital semicircles which end in one or two large pointed, keeled, and wrinkled tubercles back of the eye, separated from the last large superciliary by two or three minute scales forming a gap in the superciliary crest; on either side of the small occipital a larger polygonal shield with a high central ribbed tubercle, which with the postorbital supraocular tubercle form a nearly continuous transverse ridge; temples covered with polygonal, tuberculated scales, one group of large tubercles on the postocular semicircle and the other above the tympanic cavity which is covered with minute scales: eight narrow, elongated upper labials and seven lower ones; dorsal surface covered with small, unicarinate scales intermixed with larger scales and tubercles; a low median crest of about six enlarged, compressed, keeled scales on anterior part of upper neck, the third from the occiput being the highest; on either side several groups of enlarged scales and tubercles; no median dorsal or caudal series of enlarged scales; from the shoulders backward a median dorsal zone of small, but fairly uniformly sized, narrow, sharply keeled, imbricate scales, about six in a transversal row between a longitudinal series of en-

larged keeled scales which converge and meet at the base of the tail; lateral scales very heterogeneous, the larger tuberculated ones usually forming transverse rows, the ones at the insertion of the legs very minute, almost granular as are those in the bottom of the fold on the side of the neck; leg scales of varying size, all sharply keeled, the larger ones grouped in a patch each on upper and lower arms, thighs and femurs, the largest ones on the hind legs forming pointed tubercles larger than any on the back; scales on underside all pointed, sharply unicarinate, except under digits which are pluricarinate; tail scales fairly homogeneous, unicarinate, pointed above, a few enlarged ones above at the base. Color (in alcohol) above brownish gray with large ill-defined dusky cross patches on occiput and back separated by narrow pale cross bars equally ill-defined; a broad pale band, narrowly edged with black, across

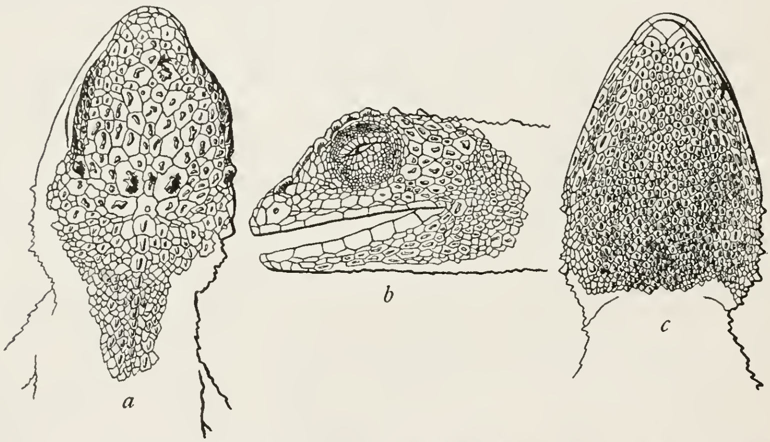

FIG. 1.—PHOXOPHRYS GRAHAMI. TYPE. U. S. NAT. MUS. NO. 65500. 2 × NAT. SIZE

forehead and supraoculars, preceded by a dark brown triangular mark which cuts angularly into the pale band; a dark brown band from orbit to angle of mouth and base of lower jaw, preceded by a pale band; lower jaw with alternating bands of pale and brown; legs and tail cross banded with dusky; a whitish, black-edged spot on each knee; underside pale gray speckled with dusky on throat.

DIMENSIONS

	mm.
Total length	134
Snout to vent	51
Vent to tip of tail	83
Snout to center of eye	8.5
Greatest width of head	12
Fore leg	24
Hind leg	35

Remarks.—The genus *Phoxophrys* was based by Doctor Hubrecht [32] upon a single specimen collected in Sumatra, which he named

[32] Notes Leyden Mus., vol. 3, 1881, p. 51.

Ph. tuberculata. Up to the present time this is the only specimen known in any museum. It is, therefore, a great surprise to find another specimen, evidently closely allied, in the Graham collection from Suifu. From Hubrecht's rather brief description, slightly altered and added to by Dr. Nelly de Rooij,[33] it is not easy to point out any radical difference between the two species, but with the aid of the figures given of *Ph. tuberculata* it seems certain that the Chinese species differs from the Sumatran one in lacking the anterior superciliary "horns," in much larger and more numerous enlarged scales and tubercles on the flanks, and fewer supralabials. In the diagnosis of the genus the body is said to be covered with small smooth scales. In *Ph. grahami* all are keeled. The descriptions of *Ph. tuberculata* do not mention any nuchal median crest of enlarged tubercles, nor is one shown on the first figure given of the species,[34] but the figure given by Miss de Rooij [35] seems to indicate that one is present. On the whole, the Graham specimen appears to be much more tuberculated and spiny than the one from Sumatra. In the latter the larger tubercles and scales are described as "multicarinate", by which I suppose the subsidiary wrinkles and ridges are meant which appear when the central keel is transformed into a more or less perfect conical tubercle. All the scales of *Ph. grahami* are unicarinate, except those on the underside of the digits which are distinctly pluricarinate.

This genus seems to be rather cosely related to *Japalura*, the chief difference being the presence of a dorsal crest in the latter. The finding of a *Phoxophrys* in China therefore is perhaps not so remarkable, indicating as it does, that the two genera have a somewhat similar geographic distribution.

Genus PHRYNOCEPHALUS Kaup

1826. *Phrynocephalus* KAUP, Isis, 1825, p. 591 (type design. by Fitzinger, 1843, *Ph. caudivolvulus*).

1831. *Megalochilus* EICHWALD, Zool. Special., vol. 3 (p. 185) (*M. auritus*).

1841. *Megalophilus* BONAPARTE, Icon. Fauna Ital., vol. 2, Introd., p. 1 (err. typogr.).

1843. *Saccostoma* FITZINGER, Syst. Rept., p. 18 (type, *Phrynocephalus auritus*).

1843. *Helioscopus* FITZINGER, Syst. Rept., p. 18 (type, *Phrynocephalus helioscopus*).

1843. *Phrynosaurus* FITZINGER, Syst. Rept., p. 18 (type, *Phrynocephalus olivieri*).

The genus *Phrynocephalus* in which Boulenger, when publishing the first volume of the Catalogue of Lizards in the British Museum (1885), enumerated 16 species, is now considered by the latest Rus-

[33] Rept. Indo-Austral. Archip., vol. 1, 1915, p. 94.

[34] Hubrecht, in Veth's Midden Sumatra, Sect. 4, Naturl. Hist., vol. 1, 1887, Rept., pl. fig. 3.

[35] Rept. Indo-Austral. Archip., vol. 1, 1915, fig. 48, p. 95.

sian herpetologists as containing more than three times as many species and subspecies. Thus Bedriaga, who in 1907–1909 published an elaborate account which amounts to a monograph of the genus, after an examination of about 1,350 specimens[36] recognized 44 species and numerous subspecies. The genus, which in many ways shows analogies with the American Iguanoid genus *Phrynosoma*, is confined to the Asiatic desert regions, from the Caspian Sea in the west almost to the Pacific Ocean in the east. Only recently Mr. Sowerby has confirmed its occurrence in China proper, though it has been known for many years from the adjacent Mongolian provinces. where numerous forms have been discovered by Russian explorers, such as Przhevalski, Potanin, and others.

A single *Phrynocephalus* collected during the expedition of Count Bela Szechenyi at "Quan-joan-shin (Kwang-yuen)" in the province of Szechwan, was identified and recorded by Steindachner as *Phrynocephalus caudivolvolus*,[37] the first record of a *Phrynocephalus* from within the boundaries of China proper. That it is not *Ph. caudivolvolus*, as at present restricted and understood, is certain, but only a reexamination of the specimen can decide to which of the many related forms it belongs.

PHRYNOCEPHALUS POTANINI Bedriaga

1907. *Phrynocephalus potanini* Bedriaga, Wiss. Res. Przewalski Central-Asien Reis., Zool., vol. 3, sect. 1, Amph. Rept., pt. 2, Nov. 9, 1907, p. 144; pt. 3, June 20, 1909, p. 389, pl. 6, figs. 7–7*b* (type locality, Hwangho and Ulan-Muren River, Ordos, China; types, Nos. 7443 and 7438 Mus. St. Petersburg; Potanin, collector).

1912. *Phrynocephalus frontalis* Sowerby, in Clark and Sowerby, Through Shen-Kan, 1912, p. 111 (Yulinfu, Shensi) (not of Strauch).

With the material at hand there is no difficulty in recognizing that the two series, collected by Sowerby in two provinces, represent two different forms, though undeniably they are closely allied and belong to the *Ph. caudivolvulus* group. On direct comparison it is plain that in one the nostrils are relatively closer together than in the other; one also has a higher head, and possibly the outline of the snout is somewhat different. One has slightly larger scales than the other, but when reduced to actual measurements the figures run together. This does not mean that the two forms are connected by "intermediates." Viewed together, as groups or individually, the observer has no difficulty in distinguishing them. In this particular instance it so happens that the species with the narrow internarial space has the larger dorsal scales, and it is thus possible to separate the two series

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[36] Wiss. Result. Przewalski Central-Asien Reis., Zool., vol. 3, Sect. 1, Amph. Rept., pt. 2, 1907, and pt. 3, 1909, pp. 134–500, pls. 3–7 and 9.

[37] Wiss. Ergebn. Reise Szechenyi Ost-Asien, vol. 2. 1898, p. 505; Hungarian Edition, 1897, p. 651.

by the contrast of the characters in combination, but that is of but scant help in determining their relation to, or identity with, other named forms known only from descriptions.

The recognition of the various forms of *Phrynocephalus* belonging to the *Ph. caudivolvulus* group is exceedingly difficult from descriptions, no matter how accurate these are, and especially perhaps when they are so elaborate and detailed as Bedriaga's. I am not questioning the validity of the various forms described, but without authentically identified material from type localities for comparison one can hardly ever be sure of the identifications. The trouble is not only that these lizards are subject to endless individual variation, but the nature of their lepidosis is such that it leaves very few definite points for measurements, so that some of the proportions to which the describers have had to resort for key characters are so vague that they give different results every time they are applied. Thus the distance from tip of snout to preocular fold is so elusive that it is hopeless to use it in connection with the internarial distance which has to be expressed in fractions of a millimeter. The "height" of the head is another uncertain character, and the distance from tip of snout to gular fold. The figures can not by any possibility be exact enough to be applicable to material of different provenience and preservation. And so with most of the characters employed, such as the carination, sharp or slight, and smoothness of the dorsal scales, the homogeneousness or heterogeneousness of the dorsal lepidosis, etc.

A careful and, let me add, laborious study of Bedriga's monograph has convinced me that the series (U. S. Nat. Mus. Nos. 39319–25) of Phrynosomas collected by Sowerby on November 9, 1908, at Yulinfu, altitude 4,000 feet, are not true *Ph. frontalis*, but *Ph. potanini.* Bedriaga's series of nine specimens, collected by Potanin at two localities in Ordos, from which Yulin is not very distant, shows a great deal of variation, the description of which covers the variations shown by Sowerby's series of seven specimens, so that I shall not add to the accumulation of details already on record. This species differs from true *Ph. frontalis* chiefly in the lower head, wider internarial space, smaller dorsal scales, and, as said before, with specimens of both species before one there is no difficulty in distinguishing them.

Mr. Sowerby has given a very interesting account of this species in life, from which I quote, as follows:

> I have not met this little lizard anywhere but in, and on the border of, the Ordos Desert. Here it may be seen in great numbers during the warmer months of the year. These little creatures are very pugnacious, and indulge in desperate battles with one another. They have a peculiar habit of rapidly

curling and uncurling their tails over their backs. This action looks very venomous, and is strongly suggestive of the vicious swishing of the scorpion's deadly caudal weapon. This lizard is of a general sandy colour above, with creamy underparts. Blotches of a darker shade occur over the body, and extending along the tail grow darker, finally ending in a series of black rings. The last half inch of the tail is black. The under surface of the tail is pale vermilion, while a crimson-mauve patch occurs behind each fore limb. The head is shaped like that of a toad, the eyes being black with white eyelids. It makes holes in the sand in which it shelters at night, or when threatened with danger.

PHRYNOCEPHALUS FRONTALIS Strauch

1876. *Phrynocephalus frontalis* STRAUCH, Opis. Presm. Zemnov. Eksped. Przhevalskago, p. 15, pl. 3, fig. 1 (type-locality, Ordos, Mongolia; types in Mus. St. Petersburg, Nos. 3920–21; Col. Przhevalski, collector).—BOULENGER, Cat. Liz. Brit. Mus., vol. 1, 1885, p. 375 (Ordos, Mongolia).—BOETTGER, Offenbach. Ver. Naturk., 24–25 Ber., 1885, p. 141 (Ordos).—?MEHÉLY in Zichy's Dritte Asiat. Forschungsreise, vol. 2, 1901, Zool., p. 47, pl. 6, figs. 3, 5, 7, 8 (Mongolia).—ELPATJEWSKI, Trudi Troitsko-Savsk. Otd. Geogr. Obshtch., vol. 9, 1906 (p. 57) (Transbaikalia).—BEDRIAGA, Wiss. Res. Przewalski Central-Asien Reis., Zool., vol. 3, sect. 1, Amph. Rept., pt. 3, 1909, p. 404, pl. 9, figs. 7–7*a* (Ordos).—NIKOLSKI, Fauna Rossij, Rept., vol. 1, 1915, p. 217 (Ordos).

1897.? *Phrynocephalus caudivolvulus* STEINDACHNER, in Wiss. Szechnyi's Kelet-Azsiai Utjanak Tudoman. Ered., vol. 2, (p. 651) (Kuan-Jaön-szhien. China), Szechenyi's Wiss. Ergebn. Reise Ost-Asien, vol. 2, 1898, p. 505.

During May 1912 Mr. Sowerby collected another interesting series (U. S. Nat. Mus. Nos. 49645–52) of *Phrynocephalus* on the plain about 30 miles southeast of Kuei-hua-cheng, in northern Shansi. They agree fairly well with the original description and with Bedriaga's very detailed reexamination of the six cotypes from Ordos (no locality specified), including his minute description of their individual peculiarities, to which I can add nothing. With regard to Mehèly's detailed enlarged drawings of the scutellation surrounding the pineal shield and the nostrils (by the way the only serviceable figures among the numerous illustrations of species of this genus) I can only say that the former does not agree with any of Sowerby's specimens, in all of which this shield is surrounded by a large number of small scales rather smaller than the dorsals, as described by Bedriaga.

Family SCINCIDAE

Genus EUMECES Wiegmann

1834. *Eumeces* WIEGMANN, Herpet. Mexic., p. 36 (type *E. pavimentatus*, design. 1835).

1839. *Plestiodon* DUMÉRIL and BIBRON, Erpét. Gén., vol. 5, p. 697 (type, designated by Fitzinger, 1843, *Pleistodon quinquelineatus*).

1843. *Pleistodon* FITZINGER, Syst. Rept., p. 22 (emendation).

1843. *Pariocela* FITZINGER, Syst. Rept., p. 22 (designated type, *Pleistodon laticeps*).

1848. *Plistodon* AGASSIZ, Nomencl. Zool. Index Univers., p. 863 (emendation).

1852. *Lamprosaurus* HALLOWELL, Proc. Acad. Nat. Sci. Philadelphia, 1852, (p. 206) (type *L. guttulatus*).

It seems desirable to recount briefly the steps by which the type of this genus has been determined.

In his Herpetologia Mexicana (1834) Wiegmann separated a subgenus *Eumeces* from the genus *Euprepis* of Wagner (1830) and included in it three species, without designating any of them as type, namely, *E. punctatus*, *E. rufescens*, and *E. pavimentatus*. During the following year, in an article reviewing his own work,[38] and before anybody else designated a genotype for *Eumeces*, he expressly states that he had erroneously included in it *Scincus rufescens* Merrem and *punctatus* Schneider; " both," he says, " belong to *Euprepes s. str.*, only *Sc. pavimentatus* Geoffr. belongs to *Eumeces*." In no more definite way could the latter be designated as the genotype. Nevertheless, in 1839, Duméril and Bibron[39] made *E. punctatus* the type and, in 1843, Fitzinger[40] designated *E. rufescens*, but their action, of course, does not influence the original determination at all.

EUMECES ELEGANS Boulenger

Eumeces elegans STEJNEGER, Herp. Japan, 1907, p. 202.—VAN DENBURGH, Proc. California Acad. Sci., ser. 4, vol. 3, Dec. 1912, p. 223 (Mokanshan, near Huchou, Chekiang).—VOGT, Sitz. Ber. Ges. Naturf. Freunde, Berlin, 1914, p. 100 (Canton).

1912. *Eumeces xanthi* BARBOUR, Mem. Mus. Comp. Zoöl., vol. 40, no. 4, Aug. 1912, p. 134 (Ichang) (not of Guenther, 1889).

After a careful examination of the young specimen in the Museum of Comparative Zoölogy (No. 7965) collected by W. R. Zappey at Ichang, the type locality of *Eumeces xanthi*, for the loan of which I am greatly indebted to my friend Dr. Thomas Barbour, I have come to the conclusion that it is a very young *E. elegans* and not *E. xanthi*. It matches in every respect specimens at hand of the former, in the number and size of scales; the absence of a postnasal; the absence of a second azygos postmental; the presence of one pair of nuchals only: presence of enlarged scales on the posterior aspect of the femur and of a keeled scale behind the corners of the arms; and in the coloration which is exactely as in Graham's specimen No. 64126 from Szechwan, Sowerby's from Foochow, and Illick's from Nanking. This latter, and in fact all the other specimens of *E. elegans* examined by me, except the Szechwan and the Wenchow specimens have the same postmental arrangement of scales, the two latter differing only in having a small median scale separating the first *paired* postmental shields which consequently are not in contact, but this ar-

[38] Archiv für Naturgeschichte, 1835, vol. 2, p. 288.

[39] Erpét. Gén., vol. 5, p. 630.

[40] Syst. Rept., p. 23.

rangement has nothing in common with the regular two azygous postmentals in the *E. chinensis* group. *E. xanthi*, judging from Guenther's description, belongs to a different group, with dorsal scales normally broader than the laterals and ventrals. Guenther himself compares his species, of which originally he had four specimens, with *E. skiltonianus*, from California, from which he says it is barely distinguishable "by a somewhat different coloration and by the postfrontals [i. e. prefrontals] being widely separated from each other, while they are more or less in contact in the American form," but apart from the fact that the latter character is worthless on account of its variability, I think it probable that *Eumeces xanthi* is closer to *E. quadrilineatus*, from Hongkong, from which it seems to differ chiefly in the number of scale rows, than to *E. skiltonianus*. This supposition is strongly confirmed by a sketch of the temporal shields kindly made for me by H. W. Parker from the type in British Museum, which shows these shields to be identical with those of *E. quadrilineatus*.

List of specimens of Eumeces elegans

United States National Museum No.	Sex and age	Locality	When collected	By whom collected	Scale rows	Dorsals	Postnasal	Postmental	Nuchals	Scales under fourth toe	Posterior loreal touching labials
22301	Juvenile	Chapu near Ningpo		B. Schmacker	26	52	0	1	1	17	2
60574		Foochow, 200 miles off		C. R. Kellogg	26	50	0	1	1	17	2
64126		Suifu, Szechwan		D. C. Graham	26	52	0	1	1	19	2
66643		do.		do.			0	1	1		2
65017		Wenchow, Chekiang	Sept. 25, 1923	C. Ping	28	50	0	1	1	18	2
65094		Nanking		J. T. Illick	26	52	0	1	1	18	2
66440	Juvenile	Foochow, Fukien		A. deC. Sowerby			0	1	1		2
66441	do.	do.		do.			0	1	1		2
66442	do.	do.		do.			0	1	0–1		2
66443	do.	do.		do.			0	1	1		2
66444	do.	do.		do.			0	1	1		2
Wisconsin University	do.	Foochow, 200 miles off		C. R. Kellogg	24		0	1			
Do.	Adolescent	do.	Jan. 13, 1909	do.	26		0	1			
M. C. Z., 7965	Juvenile	Ichang, Hupeh		W. R. Zappey	26	50	0	1	1	18	?

EUMECES CHINENSIS (Gray)

Eumeces chinensis STEJNEGER, Herp. Japan, 1907, p. 208 (Formosa).—VAN DENBURGH, Proc. California Acad. Sci., ser. 4, vol. 3, Dec. 1912, p. 225 (Shanghai).—VOGT, Sitz. Ber. Ges. Naturf. Freunde, Berlin, 1914, p. 100 (Canton).

A splendid series from the province of Fukien has been sent in by Mr. Sowerby, making it possible to study the variation of this species which has been considered less common than the other Chinese skinks. There are 25 specimens (Nos. 65343–67) from near Yenpingfu, three (Nos. 65372–4) from Futsing District, and two (Nos. 66438–9) from Foochow.

The constancy of certain characters, usually relied upon in diagnosing the species of this genus, is quite surprising. Of the thirty specimens all have two unpaired postmentals; one only (No. 65356) has a postnasal, which is quite small, but distinct and symmetrical on both sides, and one (No. 66438) has a very small one on one side; seven have 26 scale rows around the middle of the body, all the others have 24; the average number of dorsal scales on the middle line between the second nuchal and a line from groin to groin,[41] is 45, minimum 43, maximum 47; number of scales under fourth toe averages 16.4, minimum 15, maximum 17. The nuchals show the greatest variation, though only two specimens have only one pair; five have 2 on one side and 1 on the other; four have 3 on one side and 2 on the other; seventeen have 2 on each side, so that two pairs must be considered normal. This is also indicated by the fact that twenty-seven of the thirty have two at least on one side. In one specimen (No. 66439) one nuchal in the first row and one in the second row are broken up.

All these specimens are adults, uniform brownish gray with a more yellowish head and reddish spots on sides of neck and flanks, except one (No. 65366) which is much younger, 61 mm. from tip of snout to vent; the ground color of this one is also brownish gray, but very much darker than the adults; in the center of each dorsal scale there is a dusky line, forming with the others six longitudinal equidistant stripes down the back; the space between the two outer stripes and the two central ones is slightly paler than between the others, indicating the yellow stripes of the very young; no definite pattern on the head. A somewhat older one (No. 66439), 81 mm. from snout to vent, is colored essentially as the adults, but the head is yet quite narrow. A specimen from Shanghai (No. 31720 shows no essential difference from the Fukien specimens. It is included in the table following.

[41] I have preferred this line to the one back of the femurs as more easily recognized and consequently more likely to be accurately established.

List of specimens of Eumeces chinensis

United States National Museum No.	Sex and age	Locality	When collected	By whom collected	Scale rows	Dorsals	Post-nasals	Post-mentals	Nu-chals	Scales under fourth toe
65343		Near Yen-ping-fu, Fukien		A. deC. Sowerby	24	45	0	2	2	16
65344		do		do	26	45	0	2	1–2	17
65345		do		do	24	43	0	2	2	16
65346		do		do	24	45	0	2	2	16
65347		do		do	24	46	0	2	2	18
65348		do		do	24	46	0	2	2	17
65349		do		do	26	46	0	2	2–3	17
65350		do		do	24	45	0	2	2	16
65351		do		do	24	44	0	2	2–1	16
75352		do		do	26	46	0	2	2–3	16
65353		do		do	24	43	0	2	2	17
65354		do		do	24	46	0	2	2	16
65355	Male	do		do	26	47	0	2	1	16
65356		do		do	24	45	1	2	2	16
65357		do		do	24	46	0	2	2	17
65368		do		do	24	44	0	2	3–2	17
65379		do		do	24	46	0	2	2	17
65360		do		do	26	45	0	2	2	16
65361		do		do	24	47	0	2	1	16
65362		do		do	24	46	0	2	1–2	16
65363		do		do	24	45	0	2	1–2	16
65364		do		do	24	46	0	2	1½	17
65365	Male	do		do	24	45	0	2	2–0	17
65366	Juvenile	do		do	24	46	0	2	2–3	16
65367		do		do	24	45	0	2	2	17
65372		Futsien District, Fukien		do	26	43	0	2	2	16
65373		do		do	24	43	0	2	2	15
65374		do		do	24	45	0	2	2	15
66438		Foochow, Fukien		do	24	46	0–1	2	2	17
66439		do		do	26	47	0	2	1–0 0–1	16
31720		Shanghai		E. Deschamps	24	44	0	2	2	17

EUMECES PEKINENSIS Stejneger

1924. *Eumeces pekinensis* STEJNEGER, Occ. Pap. Boston Soc. Nat. Hist., vol. 5, July 26, 1924, p. 120 (type-locality, Hsin-Lung-Shan District, Imperial Hunting Grounds, Chilili, China; type, U. S. N. M. No. 60863; A. de C. Sowerby, collector).

Diagnosis.—Median dorsal scale rows not enlarged; two unpaired postmentals; lower temporal of the second row wedge-shaped; soles of hind feet nearly uniformly granular with only a few larger tubercles near the heel; a postnasal; 24 scales around the middle of the body.

Description of type specimen.—Rostral high, the portion visible from above somewhat larger than half the fronto-nasal; supranasals barely meeting behind rostral; nostril occupying most of nasal which is higher in front than behind; a small pentagonal postnasal in contact with supranasal, nasal, first and second labials and anterior loreal, the latter contact about twice as long as the others; fronto-

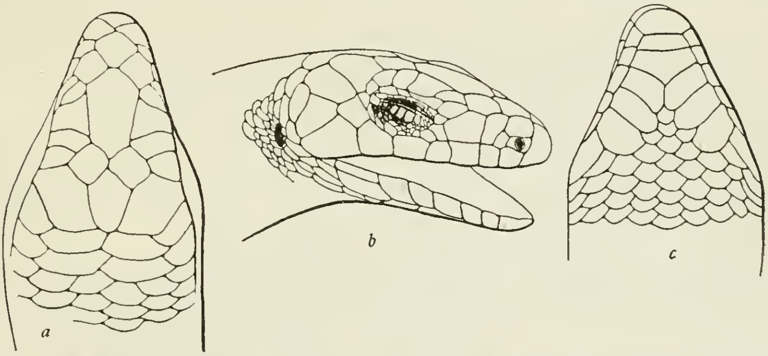

FIG. 2.—EUMECES PEKINENSIS. TYPE. U. S. NAT. MUS. NO. 60683. 3 × NAT. SIZE

nasal larger, as long as broad, barely touching rostral but in contact with frontal almost as widely as with anterior loreal; prefrontals smaller than fronto-nasal, separated from each other, in contact with frontal, fronto-nasal, both loreals, upper preocular and anterior supraocular; anterior loreal narrow, high, widening on canthus rostralis, in contact with first labial, barely touching second; posterior loreal pentagonal, large, wider than high, higher in front than behind, barely touching second labial and only in contact with fourth labial on left side; frontal considerably longer than parietals and its distance from the tip of the snout, anteriorly wider than behind, in contact with three supraoculars; four supraoculars, second largest; five superciliaries; fronto-parietals considerably smaller than interparietal; parietals shorter than frontals, widely separated behind by interparietal; two pairs of nuchals; seven supralabials, seventh largest, fifth under anterior half of eye; two large scutes covering the temples, the upper elongated with nearly parallel upper and

lower sides, in contact behind with anterior nuchals, the lower much wider behind, wedge-shaped, with the apex towards the front and narrowly in contact with the anterior temporal; two small scales between seventh supralabial and ear-opening, which is bordered anteriorly with three small lobules; mental medium, followed by two unpaired postmentals, the anterior narrow, band-like, with parallel anterior and posterior edges, the posterior larger, pentagonal, much wider than long; seven lower labials, sixth long and narrow; 24 perfectly smooth subequal scales around the middle of the body, 48 in a longitudinal series next to the median line of the back between nuchals and a line from groin to groin; a pair of large preanal plates; length of hind leg contained about twice and a half in distance from snout to vent; the adpressed limbs overlap by about the length of the fingers; scales on dorsal aspect of femur small, becoming abruptly much larger on underside, the largest being more than three times as large; sole of hind foot with subequal, small, nearly granular scales and a few larger ones near the heel; 14 scales under the fourth toe; a small scale behind each corner of the vent with a faint indication of a pointed keel or tubercle; tail gradually tapering, with a series of median, wide, transverse plates on the underside.

Color (in alcohol): above dark, nearly blackish brown, becoming paler brownish gray on terminal half of tail, with five longitudinal narrow yellowish stripes, one on the dorsal median line, the next on the middle of the third scale row from the median line, and a lateral one on the fifth and slightly also on the sixth scale row from the median line; the median stripe bifurcates on the interparietal shield proceeding forward over the frontoparietals and the lateral margins of the frontal, across the middle of the prefrontals meeting again on the rostral which is pale; the next stripe proceeds forward on the head over the outer edge of the supraoculars; the lateral stripe extends forward through the ear-opening and the lower half of the temples to the supralabials; the median stripe disappears on the terminal half of the tail, the next one on the basal third, and the lateral one just above and behind the insertion of the hind leg; underside from pectoral region forward and from groin backward pale buff, the intermediate region plumbeous, darkest on the posterior half of each scale.

DIMENSIONS

	mm.
Total length	118
Snout to vent	53
Vent to tip of tail	65
Snout to ear opening	12
Greatest width of head	8.5
Axilla to groin	29
Fore leg	15
Hind leg	22

Variation.—Two additional specimens (Nos. 60864–5), collected by Mr. Sowerby with the type, agree with it in most details as described above; in fact, there is surprisingly little variation. In the head scales the most noteworthly difference consists in the relatively smaller size of the fronto-nasal, the supranasals in both these specimens being broadly in contact behind the rostral. In both the second loreal is in contact with the second and third labials. All three specimens have a well-developed postnasal, two postmentals, two pairs of nuchals, and 24 scale rows. The dorsal longitudinal rows consist of 48 scales in one and 50 in the other; one has 15 scales under fourth toe, the other has 13. The enlarged postfemoral scales are more localized as "patches" and are scarcely as large relatively as in the type. The postanal tubercle scale is scarcely recognizable.

Remarks.—This northern species presents characters which in their combination give it a central or, in appearance at least, an intermediate position between the Eumeces of China and Japan. In some respects it recalls *E. latiscutatus*, but the double postmental, longer snout, fewer scale rows, and especially the different arrangement of the two large temporals are features more than sufficient to separate them. With *E. elegans* it shares the enlarged post femorals, the postnasal, and the unspecialized granulation of the soles, but the latter has only one postmental, one pair of nuchals, more numerous scales under the fourth toe, and a temporal scalation like *E. latiscutatus.* It agrees with *E. chinensis* in having two postmentals and in the temporal scalation, but it has a postnasal, enlarged postfemorals, and the unspecialized foot soles.

This is the most northern record of a skink in China. It is possible that the *E. marginatus* reported by Elpatjewsky and Sabanejew,[42] or *E. latiscutatus*, as the specimens have been determined by Nikolski,[43] collected at Olga and St. Vladimir Bays and at Imperator Bay on the Ussuri coast of Siberia, may be this species. On the other hand, it is not impossible that true *E. latiscutatus* may have been accidentally introduced from Japan to the opposite coast of the Sea of Japan.

EUMECES TUNGANUS Stejneger

1896. *Eumeces xanthi* GUENTHER, Ann. Mus. Zool. St. Pétersbourg, vol. 1, p. 203 (Lifang-fu and valley of Tung River, Szechwan) (not of Guenther 1889).

1924. *Eumeces tunganus* STEJNEGER, Journ. Washington Acad. Sci., vol. 14, Oct. 4, 1924, p. 384 (type-locality, Luting Kiao, where road to Tatsienlu crosses Tung River, western Szechwan, 5–6,000 feet alt.; type U. S. National Museum, No. 66736; D. C. Graham, collector).

This interesting novelty was recently described from specimens collected by Rev. D. C. Graham during his trip to Tatsienlu. He

[42] Zool. Jahrb. Syst., vol. 24, 1906, p. 255, pl. 18, fig. 3.
[43] Fauna Rossij, Rept. vol. 1, 1915, p. 508.

obtained them at practically the same locality where 29 years before the Russian explorer G. Potanin had collected specimens which Guenther, apparently misled by the fact that they had two postmentals and a postnasal, wrongly identified with the *Eumeces xanthi* which he himself described only seven years previously from specimens collected by Pratt at Ichang.

SPHENOMORPHUS INDICUS (Gray)

To synonymy in Herpetology of Japan, 1907, p. 216, add:

Lygosoma indicum BOULENGER, Ann. Mus. Civ. Stor. Nat. Genova, ser. 2, vol. 13, 1893, p. 319 (Tung-Yung Isl.).—VOGT, Sitz. Ber. Ges. Naturf. Freunde, Berlin, 1914, p. 99 (Canton).

Lygosoma (Hinulia) indicum WERNER, Mitt. Naturh. Mus. Hamburg, vol. 27, 1910, p. 43 (Foochow).

Sphenomorphus indicus VAN DENBURGH, Proc. California Acad. Sci., ser. 4, vol. 3, Dec. 1912, p. 230 (Huchow, Che-Kiang).

This widely distributed species is represented by seven specimens, two adults and one very young from Mount Wa (Nos. 65457–9), and a young from Mount Omei, Szechwan, all by D. C. Graham, one adult by Prof. Blackwelder from Shi-Chuen-Hsien, Shensi (Nos. 35527) and two, one young and one adult from near Yenpingfu, Fukien (Nos. 65369 and 65368). The latter is very large, has 38 scale rows; the young one has 40 scale rows and in both only two supraoculars touch the frontal on *both* sides; in the young one the anterior projections of the frontoparietals are abnormally separated off as two small shields. The scale rows in the others are 34 in all four Szechwan specimens, and 36 in the one from Shensi; in all these 3 supraoculars are in contact with the frontal. It will thus be seen that as Boulenger has recorded 34 and 36 scales in eleven Fukien specimens,[44] this species goes through the whole gamut of variation from 34 to 40 scale rows in that province.

LEIOLOPISMA LATERALE (Say)

For synonymy see Herpetology of Japan, 1907, p. 218, to which add:

Leiolepisma laterale BARBOUR, Mem. Mus. Comp. Zoöl., vol. 40, no. 4, Aug. 1912, p. 135 (Washan, western Szechwan; Yünnanfu).

Lygosoma reevesii GUENTHER, in Pratt's To Snows of Tibet, 1892, p. 239 (mountains north of Kiukiang; and at Mo-si-mien Pass, 12,800 ft. alt., Szechwan).

Lygosoma laterale reevesii VAN DENBURGH, Proc. California Acad. Sci. (4) vol. 3, Dec. 1912, p. 237 (China and Tsushima).

Four Chinese specimens are now before me: One from Hsin-Lung-Shan district, Imperial Hunting Grounds, Chilili, 65 miles NE. of Peking, by Sowerby (U. S. Nat. Mus. No. 60862); one from Mount Omei, Szechwan, by Graham (No. 64640), and two from Nanking, Kiangsu, one by J. T. Illick (No. 65095), and one by Prof. C. Ping (No. 65522).

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[44] Proc. Zool. Soc. London, 1899, p. 162.

These specimens show the usual variability of the species. The Szechwan specimen has 26 scale rows, the Peking one 30; the two from Nanking have 28. In other respects these two specimens which are of the same size differ more from each other than from the northern and western ones. No. 65095 is quite normal, the limbs being small, when adpressed to the side not meeting by the distance from eye to ear. In No. 65522 the tips of the longest digits meet, the feet being much better developed; in addition the internasal is divided by a regular suture.

LYGOSAURUS SOWERBYI Stejneger

1924. *Lygosaurus sowerbyi* STEJNEGER, Occ. Pap. Boston Soc. Nat. Hist., vol. 5, July 21, 1924, p. 120 (type-locality, Futsing District, Fukien, China; type, U.S.N.M. No. 65375; A. de C. Sowerby, collector).

Diagnosis.—Three large supraoculars; third supraocular in contact with parietals; parietals larger than fronto-nasal.

Description of type.—Adult: Rostral very broadly in contact with fronto-nasal; no supranasals; nostril oval, in a single nasal; no

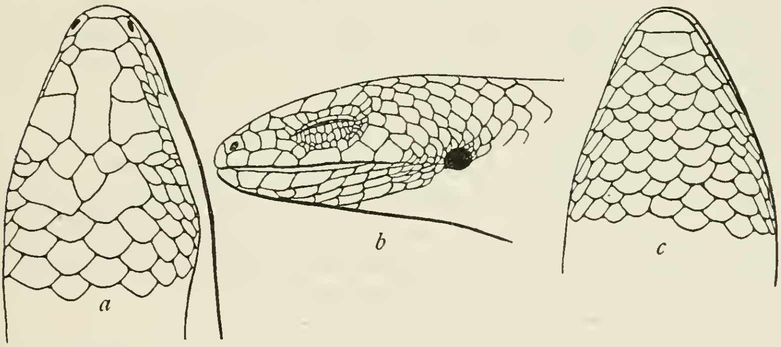

FIG. 3.—LYGOSAURUS SOWERBYI. TYPE. U. S. NAT. MUS. NO. 65375. 4 × NAT. SIZE

postnasal; fronto-nasal much broader than long, broadly in contact with frontal; prefrontals small, smaller than fronto-parietals, widely separated; frontal undivided, very long, though not quite twice as long as its distance from tip of snout, angularly emarginate laterally by the anterior supraocular, the anterior portion with the longer sides converging posteriorly, the posterior portion with the longer sides slightly diverging posteriorly, in contact laterally with first and second supraoculars, and behind with fronto-parietals and interparietal; three large supraoculars, second larger than first which is larger than third; first and second supraoculars in contact with frontal, third in contact with fronto-parietals and parietals; fronto-parietals, not in contact with each other, much smaller than third supraocular; interparietal much longer than wide, lozenge-shaped, in contact with frontal; parietals rather large, much larger

than fronto-nasal, in contact behind interparietal; no nuchals; two loreals, higher than wide, slightly smaller than prefrontals, in contact with first and second supralabials; lower eyelid scaly; six supralabials, fourth longest, about twice as long as the preceeding ones; above fifth two small suboculars; temporals undifferentiated, scale-like, smooth; ear-opening moderate, round, with no projecting lobules; a single, pentagonal, narrow shield behind the mental; submandibulars small, scarcely differentiated; 28 rows of scales around the middle of the body, of nearly equal size, those on occiput and upper neck smooth, dorsals tricarinate, the keels increasing in distinctness posteriorly and reduced to two strong keels on the lower back and tail; scales on underside smooth; preanal scales not enlarged; legs short, hind leg being contained about three and one third times in distance from snout to vent, while fore and hind legs fail to meet by the length of the foot; digits short, first especially so, covered above with smooth imbricate, alternating scales, one on each side of the median line, the terminal enlarged and covering the base of the claw; tail cylindric, longer than head and body, tapering to a point; the caudal scales above with two strong keels which extend slightly beyond the edge of each scale, underneath smooth with rounded posterior edge; no transversely elongated scales underneath.

Color (in alcohol): Above pale brown, each scale darker at the base, the keels paler, and on the tail with scattered small whitish spots; flanks speckled with small black and white spots; sides of neck, from and including the ear, with large irregular black spots; temples speckled with black; supralabials whitish; above and below by a narrow black border; underside whitish.

DIMENSIONS

	mm.
Total length	102
Snout to vent	43
Vent to tip of tail	59
Snout to ear-opening	8.5
Greatest width of head	7
Axilla to groin	23
Fore leg	9
Hind leg	13.5

Remarks.—The discovery on the Chinese mainland of a second species of this most distinct genus is highly interesting. Only one species, *Lygosaurus pellopleurus*, was known from the middle and northern groups of the RiuKiu Archipelago,[45] but no species has been recorded from Formosa, though we may confidently expect its discovery there some day.

[45] Stejneger, Herpetology of Japan, 1907, p. 222, pl. 7, fig. 3.

The new species, though evidently closely related, differs very essentially from *L. pellopleurus* not only in the characters emphasized in the above diagnosis but also in the less elongate body, the longer tail, the fewer scale keels, and the coloration. The terminal scale covering the base of the claws is also a trifle smaller. As might perhaps be expected, the mainland species is somewhat less specialized, as shown by the larger parietals, the larger supraoculars, etc., but it does not link this genus any closer with any other forms composing the unwieldly Boulengerian genus *Lygosoma*. In this connection it may be recalled what I said about *Lygosaurus* not seeming to belong to the Himalayo-Chinese fauna, having, as it does, a structure reminding one of south Indian forms rather than of any genus or species peculiar to the northern mountains.

Family LACERTIDAE

TAKYDROMUS SEXLINEATUS MERIDIONALIS (Guenther)

1864. *Tachydromus meridionalis* GUENTHER, Rept. Brit. India, p. 70, pl. 8, fig. *D* (type-locality, Southern China; types in British Mus.; J. Reeves, collector); Ann. Mag. Nat. Hist. (ser. 6), vol. 1, 1888 (p. 167).—BOETTGER, Offenbach. Ver. Naturk., 24–25 Ber., 1885, pp. 118, 142 (Canton and Lilong); Kat. Rept. Mus. Senckenberg, pl. 1, 1893, p. 79 (Nan-ning on the Yu-Kiang, prov. Kwangsi; Canton).—WERNER, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1904, p. 361.—VOGT, Sitz. Ber. Ges. Naturf. Freunde, Berlin, 1914, p. 98 (northern Kwangtung).

1887. *Tachydromus sexlineatus* BOULENGER, Cat. Liz. Brit. Mus., vol. 3, p. 4 (part: S. China); Monogr. Lacert., vol. 2, 1921, p. 151 (part: Amoy; South China).

It seems to me as if the last word about the forms which Boulenger includes in *T. sexlineatus* Daudin, has not been said yet, hence I retain the name *T. meridionalis* for the South China material at least for the present. Compared with specimens from the Malay Archipelago, which seem to be typical of *T. sexlineatus*, there appears to be enough differences to warrant the retention of the name of *T. meridionalis* in a subspecific sense. The head of the Chinese examples, five of which were collected by Mr. Sowerby in Fukien, are markedly shorter with resultant differences in the proportions of the various head shields; the number of lamellae under fourth toe are fewer; the number of inguinal pores is invariably one on each side; the prevailing number of ventral scale rows is twelve; besides differences in color and minor differences in scalation and proportion. The data relating to the South China specimens are given in the tables following.

List of specimens of Takydromus meridionalis

United States National Museum No.	Sex and age	Locality	When collected	By whom collected	Chin shields	Dorsal longitudinal rows	Dorsal transverse rows	Ventral transverse rows	Ventral longitudinal rows	Inguinal pores	Lamellae under fourth toe	Nasals in contact	Supraoculars
58326		Libon, Canton	1905		3	4	29	26	12	1	22	0 barely	3
65370		Near Yen-ping Fu, Fukien		A. de C. Sowerby	3	4	26	24	10	1	22	1	3
65371		do		do	3	4	28	24	12	1	22	1	3
65376		Futsin District, Fukien		do	3	4	29	26	12	1	23	1	3
65377		do		do	3	4	27	23	12	1	22	1	3
65378		do		do	3	4	27	24	12	1	22	1	3

Measurements of Takydromus meridionalis in millimeters

United States National Museum No.	Sex and age	Locality	When collected	By whom collected	Total	Snout to vent	Vent to tip of tail	Snout to fore limb	Length of head	Width of head	Fore limb	Hind limb
58326		Libon, Canton	1905			49		17	11.5	6.5	16	21
65370		Near Yen-ping-Fu, Fukien		A. de C. Sowerby		44		17	11	6	15	21
65371		do		do	143	53	[a] 90	18	12.3	6.5	17	23
65376		Futsin District, Fukien		do	159	49	[a] 110	18	12	6.5	16	22
65377		do		do		47		18	12	6	16	22
65378		do		do		44		16	11	6	15	20

[a] Tail reproduced.

TAKYDROMUS SEPTENTRIONALIS Guenther

For synonymy, see Herp. Japan, 1907, p. 232 (exclusive of references to Formosa). Add:

Tachydromus septentrionalis STEINDACHNER, Wiss. Ergebn. Reise Szechenyi Ost-Asien, vol. 2, 1898, p. 506 (Yumen-shien, Kansu).—BOULENGER, Mem. Asiat. Soc. Bengal, vol. 5, 1917, p. 216 (Kansu to Fukien); Monogr. Lacert., vol. 2, 1921, p. 137 (Along the Yangtse Kiang, northwest to Kansu, southeast to Fukien).

Takydromus septentrionalis VAN DENBURGH, Proc. California Acad. Sci. (4) vol. 3, 1912, p. 242 (Mohkansan and Huchow, Chekiang).

The National Museum has now eight Chinese specimens of this species, two from the province of Shensi, two from Kiangsu, three from Szechwan, and one from Fukien. The occurrence at Suifu and Mount Omei, where Mr. D. C. Graham also collected *T. intermedius*, is very interesting. The variation in the characters considered diagnostic of the species is shown in the table of specimens herewith. To be noted is, that one specimen has 4 postmentals on one side, and the larger anterior one opposite nicked in the inner edge by an incipient suture. The dorsal rows are very variable, there being 6 subequal scales in two specimens; 4 large and 2 small median rows in two; 7 rows consisting of 6 large with a median small row in two; and 1 with 6 large and 2 median smaller rows. In Nos. 65460 and 66735, the dorsal scale rows change at the middle of the back from 3–1–3 anteriorly to 2–2–2 posteriorly. In five specimens there are 2 lateral enlarged rows adjoining the ventrals on each side, while in three specimens the sutures of the rostral, nasals, and fronto-nasals meet in such a way that it is difficult to say whether the rostral and fronto-nasals touch or not. In two specimens, one from Nanking (No. 65092) and one from Szechwan (No. 65460) there is a well-developed masseteric scute on the temple. The anterior supraocular varies in size from a mere granule to a well-indicated shield. In one (No. 65092) it is absolutely wanting, and the large second supraocular in this specimen is in contact with the posterior loreal.

List of specimens of Takydromus septentrionalis

United States National Museum No.	Sex and age	Locality	When collected	By whom collected	Chin shields	Dorsal longitudinal rows	Dorsal transverse rows	Ventral transverse rows	Ventral longitudinal rows	Inguinal pores	Lamellae scales under fourth toe	Nas. in cont. behind rostr.	Supraoculars
35525	Female, adolescent	Liang Ho, Chin Ling Mountains, Shensi.		E. Blackwelder	3	7	36	30	1	8	27		4
35526	Juvenile	Hsiao Wang Chien, Chin Ling Mountains, Shensi.		do	3	6	33	29	8	1	25		4
64681	do	Spirit Valley, Nanking	Oct. 24, 1919	Cook & Loomis	3–4	8	33		8	1			4
65092	Male, adolescent	Nanking, Kiangsu Province	April, 1922	J. T. Illick	3	6	35	29	8	1	27		3
65460	Adolescent	Near Mount Wa, Szechwan		D. C. Graham	3	6	34	30	8	1	25		4
65817	Adolescent	Suifu, Szechwan	July-Aug., 1923	do	3	7	36	29	8	1	27		4
66735	Adolescent	Shen-Kai-Si, Mount Omei		do	3	7	37	28	8	1		1	4
66445	Adolescent	Foochow, Fukien		A. deC. Sowerby	3	6	32	27	8	1	26		4

TAKYDROMUS AMURENSIS Peters

For synonymy and figures, see Herp. Japan, 1907, p. 245. Add:

Tachydromus amurensis NIKOLSKI, Fauna Rossij, Rept., vol. 1, 1915, p. 271 (Ussuri; Vladivostok).—BOULENGER, Mem. Asiat. Soc. Bengal, vol. 5, 1917, p. 210, pl. 46, figs. 1–1*d* (S. E. Siberia; Manchuria; Korea); Monogr. Lacert., vol. 2, 1921, p. 129 (Ussuri; Korea).

A fine female specimen (No. 52344) of this species was collected by Mr. Sowerby on the north bank of the Yalu River, 180 miles from its mouth, in southern Manchuria. It has six dorsal series of large scales with a single median series of smaller ones; eight ventral series with at least three enlarged lateral series adjoining them on each side; there are only three pairs of chin shields, first and second being fused; rostral broadly in contact with frontal-nasal; temporals rather large; anterior supraocular not much smaller than fourth, touching second loreal.

TAKYDROMUS INTERMEDIUS Stejneger

1924. *Takydromus intermedius* STEJNEGER, Occ. Pap. Boston Soc. Nat. Hist., vol. 5, July 21, 1924, p. 120 (type-locality, Shin-Kai-Si, Mount Omei, near Kiating, Szechwan, China; type U.S.N.M. No. 64437; Rev. D. C. Graham, collector).

Diagnosis.—Head one and three-fourth times to twice as long as broad; anterior supraocular very small, mostly indicated by a minute granule; enlarged dorsals in eight longitudinal series, the two median ones smaller; ventrals in six series, smooth or very feebly keeled; four pairs of chin shields; two inguinal pores on each side; nasals in contact behind rostral; tail two and one-half times to three times the length of head and body.

Description of type specimen.—Adult female: Rostral separated from internasal by anterior nasals which are broadly in contact; posterior loreal much larger than anterior; internasal as long as prefrontals which are about two-thirds the length of the frontal; two large supraoculars, the anterior barely separated from the posterior loreal by a granule which represents the first supraocular; fourth supraocular very small, smaller than occipital; four superciliaries, two anterior ones in contact with large anterior supraocular,

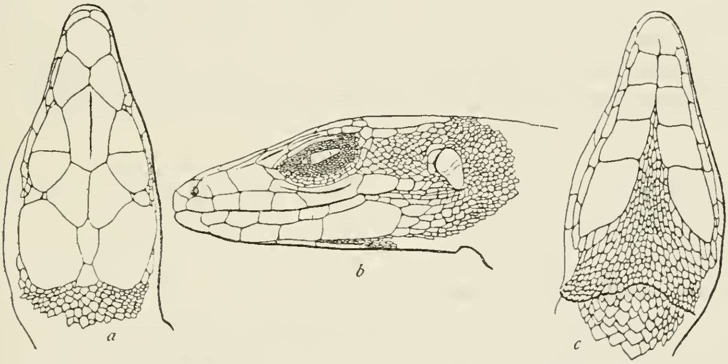

FIG. 4.—TAKYDROMUS INTERMEDIUS. TYPE. U. S. NAT. MUS. NO. 64437. 3 × NAT. SIZE

the two posterior ones separated from the second large supraocular by a series of minute granules; frontal hexagonal, with a median ridge, and much wider anteriorly than posteriorly; fronto-parietals in contact with posterior large supraocular (third) but separated from fourth by a granule; parietals large, considerably longer than frontal; four supralabials in front of the subocular labial which is largest and as long as third and fourth together; temporals small, almost granular, keeled, about 10 in a row between postocular and the elongate scales bordering the ear-opening anteriorly; a series of four elongate narrow scales along the outer edge of the parietals; four pairs of chin shields, increasing in size posteriorly, first pair in contact throughout, second only in anterior half; eight dorsal rows of keeled scales, the two median series small and irregular, on the posterior half of the back reduced to a single row; keels of large dorsals forming continuous ridges, four of the large dorsals corresponding to about four and one-half ventral plates; sides covered with minute

keeled scales gradually enlarging toward dorsals and ventrals, about 14 in a transverse row; scales on upper surface of limbs, like dorsals, the largest scarcely smaller; gulars granular, considerably elongated anteriorly between the chin shields and merging gradually posteriorly into the pointed and keeled scales covering lower neck and collar, about 29 granules and scales on the median line between chin shields and collar; a distinct gular fold; 6 rows of ventral plates, all smooth except outer row which is slightly narrower, keeled and pointed, abruptly set off from the adjoining small-keeled scales of the flanks, 25 on the median line from collar to preanal plate; preanal plate large, smooth, with two narrow scales on each side; two inguinal pores on each side; subdigital lamellae under fourth toe 27; tail three times as long as head and body together with strongly keeled and pointed scales which are about as long as the large dorsals.

Color (in alcohol): Dark olive gray, outer dorsal row faintly paler; a narrow pale line from posterior supralabials on side of neck below tympanum to shoulder; entire underside bluish gray except underside of arms and legs (but not hands and feet) whitish.

DIMENSIONS	*mm.*
Total length	210
Snout to vent	52
Vent to tip of tail	158
Snout to collar	18
Snout to posterior edge of occipital	13
Snout to ear-opening	11.5
Snout to posterior edge of ear-opening ("length of head")	13
Greatest width of head	7
Fore leg	20
Hind leg	27

Variation.—The variations of the five specimens in proportions and structural details may be seen from the appended tables. It may be added that all have the nasals in contact behind the rostral. The internasal, or fronto-nasal, is not always as long as in the type; the first (small) supraocular, may be almost as large as the fourth, or may be reduced to a mere pin point; second pair of chin shields may be in contact throughout their length; otherwise there is a very great uniformity in the series.

Remarks.—The Szechwan species here described seems to be so intermediate between the various forms of this genus as to well merit the name I have given it. An attempt to identify the five specimens before me by the "Synopsis" in Boulenger's excellent Monograph of the Lacertidae,[46] at once demonstrates the central po-

[46] Vol. 2, 1921, p. 128.

sition of the species here described. In that synopsis the species of this genus are divided into those with " I. Head not more than one and three quarter times as long as broad," and those with " II. Head at least nearly twice as long as broad"; in other words, the ratio between breath and length of head in Group I is 1:1.75, or less; in Group II it is " nearly " 1:2, or more, or if we interpret the " nearly " as " minus 0.1 " the ratio in Group II may be said to be 1:1.85. The table of measurements shows that in the new species the ratio varies between 1:1.75 and 1:2, averaging in the five specimens 1:1.88, or halfway between the two groups with a leaning towards Group II. That this is the correct interpretation is evident from an examination of the ratios given by Boulenger himself for three of the species composing Group II, namely, *T. smaragdinus*, *T. sauteri*, and *T. sexlineatus*, in which according to his figures the ratios are respectively 1:1.85; 1:1.93 and 1:1.98. The Szechwan specimens must therefore be tested both in Groups I and II, and as the elongated head points towards the latter, they may be looked for first in that category. Having eight dorsal rows of scales (or plates) and ventrals in six series they ought to be found under *A*, and having four pairs of chin shields they might be suspected of belonging to *T. sauteri*, hitherto only known from Formosa. But this is a very different species with sharply keeled ventrals, one inguinal (femoral) pore, two or three series of keeled scales on the sides above the ventral plates and only 24 lamellae under fourth toe. Tried in Group I, which falls in two Groups *A* and *B*, the latter with four dorsal series, 12 ventrals and three pairs of chin shields, they should be looked for in Group *A* in spite of the fact that the species contained in that group are said to have ventrals in eight or 10 series, while our specimens only have six. *A* is divided in those with "*1*. four or five pairs of chin shields" and "*2*. three pair of chin shields." As ours have four pairs the choice is limited to *T. amurensis*, *T. tachydromoides*, and *T. wolteri*. Of these *T. amurensis* has three inguinal pores, and *T. wolteri* one pore, and both have eight ventral series, while ours have two pores and six ventral series. Finally, *T. tachydromoides*, from Japan, like our species, has two inguinal pores and four chin shields, but the number of dorsals and ventrals is reversed, namely, six dorsal and eight ventral rows, while *T. intermedius* has eight dorsal and six ventral rows, besides, having much longer head and various peculiarities of its own, such as the numerous granules covering the temples, lack of well-developed " plates " on the flanks adjoining the ventrals; more numerous lamellae under the fourth toe; nasals in contact behind rostral, etc.

List of specimens of Takydromus intermedius

United States National Museum No.	Sex and age	Locality	When collected	By whom collected	Chin shields	Dorsal scale rows	Dorsal transverse rows	Ventral transverse rows	Ventral longitudinal rows	Inguinal pores	Lamellae scales under fourth toe
63594	Adolescent	Suifu, Szechwan		D. C. Graham	4	8	35	26	6	2	28
64425	do	Mount Omei, Szechwan	1921	do	4	8	30	24	6	2	28
64437 [a]	do	Mount Omei, Shin-Kai-Si, Szechwan	1921	do	4	8	32	25	6	2	27
65467	do	Mount Omei, Szechwan		do	4.5	8	31	25	6	2	27
65933	do	Suifu, Szechwan	1923	do	4	8	34	24	6	2	27

[a] Type.

Measurements of Takydromus intermedius in millimeters

United States National Museum No.	Sex and age	Locality	When collected	By whom collected	Total	Snout to vent	Vent to tail tip	Snout to fore limb	Length of head	Width of head	Fore limb	Hind limb	Feet
63594	Adolescent	Suifu, Szechwan		D. C. Graham	160	48	112	19	12	6	19	25	13
64425	do	Mount Omei, Szechwan	1921	do	181	48	133		12	6.5			
64437 [a]	do	Mount Omei, Shin-Kai-Si	1921	do	210	52	158	19	13	7	20	27	14
65467	do	do		do	138	36	102		10.5	6			
65933	do	Suifu, Szechwan	1923	do	197+	55	142+		13.5	7			

[a] Type.

EREMIAS ARGUS Peters

For synonymy see Herpetology of Japan, 1907, p. 248, to which add:

Eremias argus STEINDACHNER, Wiss. Ergebn. Reise Szechenyi Ost-Asien, vol. 2, 1898, p. 505 (Su-chou, Kansu).—ELPATJEWSKY and SABANEJEW, Zool. Jahrb. Syst., vol. 24, 1906, p. 252 (Gussonoye Osero, Seleginsk Distr., Transbaikal).—SOWERBY, in Clark and Sowerby's Through Shen-kan, 1912, p. 110 (Kansu).—BEDRIAGA, Wiss. Res. Przewalski Central-Asien Reis., Zool., vol. 3, sect. 1, Amph. Rept., pt. 4, June, 1912, p. 636 (Ordos; Alashan).—NIKOLSKI, Fauna Rossij, Rept., vol. 1, 1915, p. 460 (Mongolia, etc.).—BOULENGER, Monogr. Lacertid., vol. 2, 1921, p. 336 (Manchuria, Korea, Mongolia, North China).

Ten specimens of this species have been collected by Sowerby on three of his expeditions to the Mongolian frontier, namely, two (Nos. 39340 and 39341) from the province of Kansu, the first at a locality 5 miles south of San-chow-fu (about 5,100 feet altitude) on June 21, 1909, and the second one near Ching-yang-fu (about 3,100 feet) on August 8, 1909; one (No. 49644) at Kuli-hua-cheng, northern Shansi, during May, 1912; and seven at the Imperial Hunting Grounds, Chilili, 65 miles N. E. of Peking during August, 1917.

They show the usual variations of this species, but none have the subocular forming part of the labial edge, as in the so-called *E. brenchleyi*, nor do any of the specimens approach the other characters attributed to this much debated form. In all the specimens the fronto-nasal is divided, except in No. 49644, nor does this specimen have any small scales or granules intercalated on the snout; in addition, it possesses an unusually small interparietal. Among the other specimens, No. 39340 from LanChow, Kansu, which I have examined very closely for possible relationship to *E. multiocellata*, which has also been recorded from Kansu (type specimen of *E. planiceps* Strauch), has a divided fronto-nasal, and the length of the anterior large supraocular is not greater than its distance from the second loreal.

It is true that an occasional specimen of *E. multiocellata* is found with a divided fronto-nasal (Petrograd Mus. No. 5124, from Balgantai-gol, Tian-shan, Col. Przhevalski, collector) and that the granules filling the anterior supraocular triangle are unusually large and coarse, but this space itself is not smaller than in typical *E. argus*, and the specimen does not otherwise differ from normal individuals of this species.

Family ANGUIDAE

Genus OPHISAURUS Daudin

For synonymy see Proc. U. S. Nat. Mus., vol. 38, May 3, 1910, p. 102.

OPHISAURUS HARTI Boulenger

1899. *Ophisaurus harti* BOULENGER, Proc. Zool. Soc. London, 1899, p. 160, pl. 16 (type locality, Kuatun, Fukien, China; cotypes in Brit. Mus.; J. D. La Touche, collector.)—STANLEY, Journ. N. China Asiat. Soc., vol. 45,

1914, p. 26 (Fukien); vol. 47, 1916, p. xiv (Fukien).—STEJNEGER, Proc. Biol. Soc. Washington, vol. 32, June 27, 1919, p. 142 (Formosa; within 200 miles of Foochow, Fukien).—WERNER, Mitt. Naturh. Mus. Hamburg, vol. 27, 1910, p. 27 (Fukien).

1905. *Ophisaurus ludovici* MOQUARD, Bull. Mus. Nat. Hist., Paris, 1905, (p. 76) (type-locality, Bao-Lac, Tonkin, near Chinese frontier; type in Paris Mus.; Louis Vaillant, collector); 1910, p. 1, figs. 1*a–c*.

In addition to the specimen (No. 60575) collected by C. R. Kellogg "within 200 miles of Foochow," already recorded by me, the National Museum has recently received from C. H. Barlow an adult specimen, with reproduced tail, from Moh-Kan-Shan, Chekiang. This specimen which is without cross-markings is (in alcohol) of a pale bluish gray above, slightly darker on the six median scale rows; at about halfway between dark bluish gray stripe begins on the center of the fourth scale row from the lateral groove, which increases in width and intensity backards until on the side of the tail it occupies the adjacent halves of third and fourth scale rows. The head scales are essentially like Boulenger's figure of the type, except that the occipitals are slightly larger and better differentiated. There are 104 transverse series of body scales counted from beginning of laterial groove to vent; dorsals and ventrals, in a series around the body, are 16 and 10 respectively.

Suborder SERPENTES

Family TYPHLOPIDAE

TYPHLOPS BRAMINUS (Daudin)

For synonymy see Herpetology of Japan, 1907, p. 260, to which add:

Typhlops braminus STANLEY, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 26 (Fukien).

Typhlops bramineus STANLEY, Journ. N. China Asiat. Soc., vol. 47, 1916 p. xiii (Yeung Yang, south China); p. xv (Changning via Swatow).

A young specimen (No. 65380) from the Futsing district, Fukien, has been received from Mr. Sowerby.

Family COLUBRIDAE

Genus SIBYNOPHIS Fitzinger

See Stejneger, Proc. U. S. Nat. Mus., vol. 38, May 3, 1910, p. 102.

SIBYNOPHIS COLLARIS[47] CHINENSIS (Guenther)

1889. *Ablabes chinensis* GUENTHER, Ann. Mag. Nat. Hist. (ser. 6), vol. 4, p. 220; in Pratt's To Snows of Tibet, 1892, p. 240 (type locality, Ichang, Hupeh; type in Brit, Mus.; A. E. Pratt, collector).

1893. *Ablabes sinensis* BOULENGER, Cat Snakes Brit. Mus., vol. 1, pp. 184, 185, 444 (emendation in synonymy).

[47] For Synonymy of *S. collaris collaris* see Proc. U. S. Nat. Mus., vol. 38, 1910. p. 103, to which add: *Polyodontophis collaris* WALL, Proc. Zool. Soc. London, 1903, p. 85 (Hong Kong Island).

1899. *Polyodontophis collaris* BOULENGER, Cat. Snakes Brit. Mus., vol. 1, pl. 12, fig. 1*b*–1*c* (Ichang, Hupeh); Proc. Zool. Soc. London, 1899, p. 162 (not of Gray) (Kuatun, Fukien).—ANGEL, Bull. Mus. Hist. Nat. Paris, 1920, no. 2, p. 112 (Kweichow).

The specimen from Ichang, upon which Guenther based his *Ablabes chinensis*, has two anterior temporals, as mentioned and figured by Boulenger (pl. 12, fig. 1 *c*), the lower one being interpreted as the eight supralabial " excluded from the labial margin." [43] Boulenger, however, reduced Guenther's name to a synonym under *Polyodontophis collaris*, of which he had 11 specimens from the Khasi Hills, Nepal and Darjeeling, in the Himalaya, as well as from Burma, none of which had a separate lower anterior temporal. Later he received two specimens from Kuatun, Fukien, both of them agreeing with Guenther's type from Ichang in the temporal arrangement, but having found this character to be inconstant in *P. subpunctatus* and *P. bistrigatus* he expected that it " would likewise break down if a larger number of Chinese specimens could be examined."

The United States National Museum has two more specimens to add to the Chinese record, viz, No. 66435 collected by Sowerby at Foochow, and No. 35521 from Shih-chuan-hsien, on the Han River in southern Shensi, by Prof. E. Blackwelder. In both of these the lower anterior temporal is widely separated from the labial edge, as is also the arrangement in the type specimen as figured by Boulenger (fig. 1*c*). If this figure be compared with that of the normal *S. collaris*, fig. 1*a*, it will be seen that this temporal is really the upper part of the eight labial separated off and not the eight labial forced off the labial edge. It should also be noted that in the two specimens before me the parietal is in contact with the lower postorbital, a character supposed to distinguish *S. geminatus* and *S. subpunctatus*. In addition to the separate lower temporal, the five Chinese specimens known show a greater number of ventrals than the western form. From the table given below, it appears that the former have from 178 to 187 ventrals, while in the nine specimens of the latter listed by Boulenger, the number of ventral ranges between 159 and 180. Finally, our specimens from Shensi and Fukien agree exactly in color pattern with that of the type from Ichang (Boulenger, fig. 1*b*) as contrasted with that of the regular *S. collaris* (fig. 1.).

Taking all the above facts into consideration, I consider it desirable to retain the name given by Guenther for the Chinese specimens.

Since the above was set in type the National Museum has received another specimen from Mr. Sowerby, collected at Kuliang. It is

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[43] Probably similarly interpreted by Guenther, as he gives the temporal formula as 1 + 2 in the original description.

essentially like the two other specimens, having the lower anterior temporal widely separated from the labial edge, but the parietal is separated from the lower postorbital. It is a female, No. 67737 and its scale formula is as follows: sc. 17; v. 178; a. 2; subc. 124; oc. 1–2; t. 2+2; supral. 9.

List of specimens of Sibynophis chinensis

Museum	No.	Sex and age	Locality	When collected	By whom collected	Scale rows	Ventrals	Anal	Subcaudals	Oculars	Temporals	Supralabials
British	Type		Ichang, Hupeh		A. E. Pratt	17	[a] 187			1–2	2+2	9
Do			Kuatun, Fukien		J. D. La Touche		184				2+2	
Do			do		do		178		110		2+2	
United States National	35521	Female	South Shensi		E. Blackwelder	17	187	2	110	1–2	2+2	9
Do	66435	Male	Fuchow, Fukien		A. deC. Sowerby	17	180	2	117	1–2	2+2	9

[a] Acc. to Boulenger; Guenther's original description has 182.

Genus NATRIX Laurenti

Three names of water snakes (*Natrix*) occurring in southeastern China cluster around the identical scale formula: 19 sc.; 132-164 v.; 2 a.; 51-77 subc.; 1-3 or 4 oc.; 2+3 temp., namely, *N. annularis*, *N. habereri*, and *N. percarinata*. This formula overlaps that of a fourth species of wide distribution but extending its range into the same region, namely *N. piscator*, the formula of which is: 19 sc.; 125-150 v.; 2 a.; 70-90 subc.; 1-3 (4) oc.; 2+2 or 3 temp. The character relied upon for distinguishing the latter has been that two or three outer scale rows were supposed to be smooth and only one in the other three forms. We now know that this distinction does not hold. Speaking of the character assigned to *Natrix asperrima*, viz, one unkeeled row of scales as against two or three in *N. piscator*, Doctor Wall states that he examined many hundreds of Indian *piscator* and found that the number of rows not keeled is variable. He also examined several of the Ceylon form *asperrima* most critically, besides the Indian *piscator*, and could not discover any constant character whereby the two can be separated. In addition it now turns out that both the types of *N. annularis* and *N. habereri* have three smooth, or nearly smooth, outer scale rows, and that in several other specimens of this form the second scale row is more or less smooth. It will be noticed, however, that in the

scale formulas as given above *N. piscator* has a relatively shorter body and longer tail, but no absolute line can be drawn; it also has the fourth and fifth supralabials entering the eye, but we have numerous examples of *N. annularis*, etc., in which the fifth labial touches the eye, though possibly not to the same extent.

In *N. piscator*, moreover, the second row of temporals usually consists of only two scales. Concomitant with this we find that the

Number of ventrals and subcaudals in Natrix piscator, percarinata, and annularis based on published records of 72 specimens

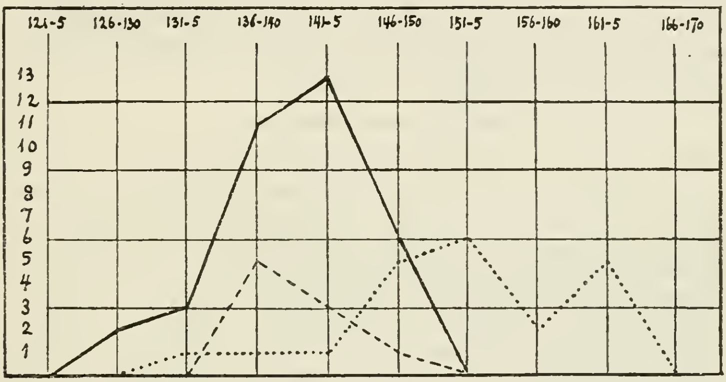

FIG. 5.—Number of ventrals:
——————— *Natrix piscator*, 43 records.
_ _ _ _ _ _ _ _ *Natrix percarinata*, 8 records.
. . . . *Natrix annularis*, 21 records.

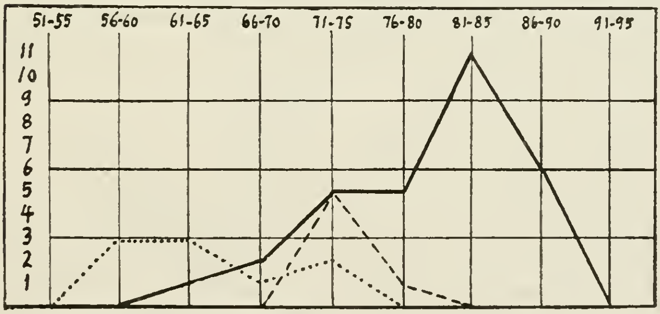

FIG. 6.—Number of subcaudals:
——————— *Natrix piscator*, 30 records.
_ _ _ _ _ _ _ _ *Natrix percarinata*, 6 records.
. . . . *Natrix annularis*, 18 records.

(normally) eighth supralabial is pentagonal and much higher, with an angular upper border much greater than the labial border, while in *N. annularis* this shield is nearly quadrangular with parallel upper and lower borders. These characters in conjunction with the strongly marked color-pattern of the postocular region in *N. piscator* suffice in all cases to identify this common species.

The scale formula of the three other names upon further analysis will be found to be composite. The curves of the number of ventrals and subcaudals (figs. 5–6) show that in reality *N. percarinata* has the same short body and long tail as *N. piscator*, while in *N. annularis* the body is relatively much longer and the tail shorter. No separate diagram of *N. habereri* could be given as only the extremes of the six cotypes are given, namely, 163–164 ventrals and 53–65 subcaudals, but these figures are clearly within the curve of *N. annularis*. As the chief distinction of *N. habereri* is supposed to be the smoothness of the three outer scale rows and as this character has been shown to be of no significance, there can scarecely be any objection to following Boulenger's example in regarding *N. habereri* as a synonym of *N. annularis*.

NATRIX ANNULARIS Hallowell

1856. *Tropidonotus annularis* HALLOWELL, Proc. Acad. Nat. Sci. Philadelphia, 1856, p. 151 (type-locality, Ningpo, China; type in Mus. Phila. Acad.; Dr. McCarter, collector).—BOULENGER, Cat. Snakes Brit. Mus., vol. 1, 1893, p. 233; vol. 3, 1896, p. 605 (Mts. N. of Kiukiang; Chikiang; Ningpo; Da-laen-saen, SW of Ningpo; Formosa).—WERNER, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p. 363.—STANLEY, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 28 (Kiangsu; Chekiang; Fukien).—GEE, Journ. N. China Asiat. Soc., vol. 50, 1919, p. 184 (Soochow, Kiangsu).

Natrix annularis STEJNEGER, Herp. Japan, 1907, p. 291 (Formosa).

1859. *Tropidonotus chinensis* "Jan" BERTHOLD, Nachr. Univ. Ges. Wiss. Goettingen, No. 17, Sept. 12, 1859, p. 180 (type locality, China; type in Mus. Goettingen).

1859. *Tropidonotus semifasciatus* BERTHOLD, Nachr. Univ. Ges. Wiss. Goettingen, No. 17, Sept. 12, 1859, p. 180 (alternative name).

190. *Tropodonotus habereri* WERNER, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 190, p. 54, pl. 1, figs. 1–2 (type locality, Ningpo Mts. near Shanghai; types in Mus. Munich; Dr. Haberer, collector).

Two specimens from Fukien, No. 64644 collected by C. R. Kellog at Kuliang, and No. 65409, by Mr. Sowerby at Foochow, belong undoubtedly to this species. This is rather surprising in view of the fact that the related *N. percarinata* was described from this province. Nevertheless, both structurally and in coloration they are typical *N. annularis*. The scale formulas are given below. In addition it may be stated that No. 65409 on both sides and No. 64644 on the left side have nine supralabials, fifth higher than fourth and sixth, and exclusively touching the eye, while on the right side there are only eight labials, the fourth only touching the eye. In both specimens the rostral is nearly as wide as high, the interparietal suture is as long as the frontal and longer than the latter's distance from the tip of the snout, and the diameter of the eye equals the width of the frontal in the middle. In both, the keels on the second scale row are very faint or even entirely absent. No. 64644 has 38 black rings on the under side of the body No. 65409 has 39. Both have supralabials white, edged with black.

List of specimens of Natrix annularis

United States National Museum No.	Sex and age	Locality	When collected	By whom collected	Scale rows	Ventrals	Anal	Subcaudals	Labials	Oculars	Temporals	Smooth scale rows
64644	Female	Kuliang, Foochow, Fukien	Aug. 21, 1921	C. R. Kellogg	19	152	2	?	9/8	1-3	2+3	2
65409	Female	Foochow, Fukien	do	A. deC. Sowerby	19	151	2	59	9	1-3	1+3 / 2+3	2
66856	Male	Wenchow, Chekiang		Prof. C. Ping	19	161	2	53-	9/8	1-3	2+3	2

NATRIX AEQUIFASCIATA Barbour

1908. *Natrix aequifasciata* BARBOUR, Bull. Mus. Comp. Zoöl., vol. 51, no. 12, April, 1908, p. 317 (type-locality, Mt. Wuchi, Central Hainan; type. Mus. Comp. Zoöl., No. 7101).

Karl P. Schmidt, after examination of the type, has kindly informed me that a specimen from Fukien in the National Museum, which I showed him during his recent visit in Washington, belongs to Barbour's species, originally described from the island of Hainan. Doctor Barbour, to whom I then submitted it for direct comparison with his type material, writes me as follows:

The *Natrix* arrived and we, i. e., Mr. Loveridge and I, compared it most critically with our two cotypes of *N. aequifasciata*. They are surely the same. At first sight our specimens looked widely different but they are young and the widebowled, black and white crossbars evidently disappear with age to be almost obliterated as with your big specimen, while the ventral blotches mark the position of the rings.

As regards details of head squamation there are no differences worth mentioning. The heads are shorter in our two cotypes, no doubt an age character and the only thing which suggests that possibly a series might prove separable, did we have adults and young from the two localities, is the fact that in both of the Hainan specimens the prefrontals tend to be proportionately a little shorter than in the snake from the mainland. The pre and postocular regions and the temporal regions show some little variability for one of our cotypes has two preoculars on both sides and the other but one, while one has three postoculars on one side and four on the other, the second specimen has four on both, the fourth a tiny scale so placed that it might be almost called a subocular. Then on one side of one of my cotypes the two anterior temporals are fused into a single large scale which is followed by three temporals. In the other case this same condition of 2+3 obtains, but the five scales vary greatly in shape, size and position.

The specimen (U. S. Nat. Mus. 65389) is a male, collected by Mr. Sowerby at Yenping-fu, with tuberculated chin-shields; the body scales are very strongly carinated, even some of the outer row showing indications of keel; the rostral is less high than in *N. annularis*, and is only just visible from above; the parietals are very short, the interparietal suture being shorter than the frontal and shorter than the latter's distance from the rostral; the snout is very elongate, as shown by the exceedingly long internasals, the long anterior nasal, the long loreal which is much longer than high; the supralabials, nine in number, are unusually long, especially the seventh; they are of subequal height, even the fifth which borders the eye below; three postoculars, of which the lower one is small and triangular so that the upper anterior corner of the sixth supralabial just touches the eye; the eye is relatively large, the diameter considerably exceeding the width of the frontal at the middle; frontal rather large with concave sides. The scale formula is as follows: sc. 19; v. 148; a. 2; subc. 73; l. 9; oc. 1.–3; temp. 2+3.

It will thus be seen that structurally it agrees very well with the original description of *N. percarinata* which Boulenger characterizes as distinguished from *N. annularis* by the larger eye, broader rostral and shorter parietals.

The coloration, however, is very different, except in the absence of dark edges to the supralabials. Boulenger's type has "the four anterior upper labials grayish olive like the upper surface of the head, the rest uniform yellowish white like the lower surface" and our specimen has them all dark, but that seems of little importance and may have to do with the greater size of the latter (718 mm. long; tail 168 mm. against 500 and 130 mm. of the type). However, the body pattern is different. Boulenger describes the type as being "grayish olive above, sides with light edged black vertical bars; belly uniform yellowish white anteriorly, spotted and speckled with blackish posteriorly; lower surface of tail with some black spots." Sowerby's specimen is brownish above with a pattern of more or less rhombic spots of a more grayish color with broad margins of dark brown; these brown margins on the sides form with corresponding black margins coming up from the belly a distinct large X; the black ventral margins on the anterior third of the underside of the body extend more or less continuously across the belly enclosing a space of the yellowish white ground color, but further back each pair becomes consolidated into a broad black mark 3–4 ventrals wide either forming a continuous broad black ring across the belly, or alternat-

ing on the mid line with the corresponding pattern of the other side; on the body there are about 20 such black rings or half-rings; on the underside of the tail there are about 12, the larger ones being 5 to 6 pairs of subcaudals wide; on the posterior half of the underside the light interstices are mottled with brownish gray.

NATRIX PERCARINATA (Boulenger)

1899. *Tropidonotus percarinatus* Boulenger, Proc. Zool. Soc. London, 1899, p. 163, pl. 17, fig. 2 (type locality, Kuatun, Fukien; type in Brit. Mus.; J. D. La Touche, collector).—Wall, Proc. Zool. Soc. London, 1903, p. 67 (Sikawei, Shanghai).—Werner, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p. 354 (Ningpo mountains).

Boulenger's species was based on a single male specimen from Kuatun, Fukien. Since the original description appeared, specimens from near Shanghai have been referred to it by Doctor Wall and by Doctor Werner.

Two specimens which I refer to *N. percarinata* were collected by Mr. Graham at Si-gi-pin, Mount Omei, Szechwan. Compared with *N. aequifasciata* they have a less elongate snout with relatively shorter loreal and internasals; the supralabials are rather elongate, however, especially the three posterior ones. In both specimens the sixth supralabial is excluded from the eye by the subpostocular, but in No. 66635 the fourth touches the eye on both sides. The eye is rather large, the diameter exceeding the width of the frontal at the middle in this specimen. The frontal is very large in both, in No. 66635 with concave sides; parietals short, the suture between them equaling or shorter than the distance of frontal from tip of snout. The scale formula is as follows:

No. 65455 sc. 19; v. 140; a. 2; subc. . . .; l. 9; oc. 1–4; t. 2+3.
No. 66635 sc. 19; v. 139; a. 2; subc. 52; l. $\frac{9}{10}$; oc. 1¾; t. 2+3.

The dorsal scales are very strongly keeled, but the two outer scales are smooth and the third smooth or very weakly keeled.

In coloration the Mount Omei specimens differ considerably from *N. aequifasciata*. The upper side is nearly uniform gray with faint indications of dusky cross bars more or less continuous with the lateral markings which are more like those in the type of the species, except that they are pale in the middle. The underside, however, while lacking in the bold black cross blotches of the *N. aequifasciata*, nevertheless approach the latter in having indication of a similar pattern with the center of the cross bars faded out. In both specimens the labials are dark like the rest of the head without the blackish edges to the sutures which are characteristic of *N. annularis*.

It must be admitted that Boulenger's dictum that *N. percarinata* is closely allied to *N. annularis* is correct, but the characters, as indicated above, seem to justify its retention as a distinct form.

NATRIX PISCATOR (Schneider)

To the synonymy in Herpetology of Japan, 1907, p. 288, add:

Tropidonotus piscator STANLEY, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 28 (Chekiang and Fukien); vol. 46. 1915, p. xiii (Swatow, Kwangtung).

No less than ten specimens from Fukien, viz., Nos. 64643, from Kuliang collected by C. R. Kellogg, Nos. 65381–4, from the Futsing district, Nos. 65404–7 and 66437, from Foochow, all by Sowerby, representing adults and young, testify to the uniformity of this species in the region mentioned. Curiously enough, these are the only specimens of true *N. piscator*, which the National Museum has received from China proper, with the exception of the type of *Amphiesma flavipunctatum* Hallowell, which is typical in scutellation and structure, a remark perhaps not superfluous in view of the various closely related forms which have been described since.

NATRIX NUCHALIS (Boulenger).

1889. *Tropidonotus swinhonis* GUENTHER, Ann. Mag. Nat. Hist. (ser. 6), vol. 4, Sept. 1889, p. 221 (Ichang, China) (not of 1868); in Pratt's To Snows of Tibet, 1892, p. 241 (Ichang).

1891. *Tropidonotus nuchalis* BOULENGER, Ann. Mag. Nat. Hist. (ser. 6), vol. 7, 1891, p. 281 (type-locality, Ichang, Hupeh, China; cotypes in Brit. Mus.; A. E. Pratt, collector); Cat. Snakes Brit. Mus., vol. 1, 1893, p. 218, pl. 13, fig. 1 (Ichang).—WERNER, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p. 363.—WALL, Proc. Zool. Soc. London, 1903, p. 86.

Natrix nuchalis STEJNEGER, Herp. Japan, Bull. U. S. Nat. Mus. No. 58, 1907, p. 294.

Mr. Graham has sent no less than five specimens of this interesting species from various localities about Mount Omei, Szechwan. These specimens show very little individual variation, and it is particularly interesting to observe how constant is the consolidation of the long fifth supralabial. The nuchal groove is also well marked. The individual scale formulas are shown in the appended table.

List of specimens of Natrix nuchalis

United States National Museum No.	Sex and age	Locality	When collected	By whom collected	Scales	Ventrals	Anal	Subcaudals	Labials	Oculars	Temporals
64431	Male	Mount Omei, Szechwan	1921	D. C. Graham	15	158	2	51+	5	1–2, 1–3	1+1
65501	do	do	Aug., 1922	do	15	156	2	61	5	1–3	1+1
65503	Female	Si-Gi-Pin, Szechwan		do	15	152	2	49	5	1–3	1+2
65504	do	do		do	15	155	2	46	5	1–3	1+2
66645	Male	Shin-Kai-Si, Szechwan	July, 1923	do	15	152	2	57	5	1–3	1+2

NATRIX STOLATA (Linnaeus)

Synonymy in Herpt. Japan, 1907, p. 280, to which add:

Tropidonotus (*Amphiesma*) *stolatus* MUELLER, Verh. Naturg. Ges. Basel, vol. 6, pt. 4, 1878, pp. 603, 675 (Prov. Kwangtung, China, etc.).

Tropidonotus stolatus BOETTGER, Offenbach. Ver. Naturk., 24–25 Ber., 1885, p. 150 (Nienhong-li near Hongkong).—WERNER, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p. 363.—STANLEY, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 28 (Fukien); vol. 47, 1916, p. xiv (Ningteh, Fukien).

Four specimens, one from C. R. Kellogg (No. 64642), and three by Mr. Sowerby (Nos. 65390, 65397, 65403), all collected at or near Foochow and Yen-ping-fu, seem to indicate that this widely distributed species is not rare in Fukien.

NATRIX TIGRINA LATERALIS (Berthold)

Synonymy in Herp. Japan, 1907, p. 278, to which add:

Tropidonotus tigrinus SOWERBY, in Clark and Sowerby, Through Shên-Kan, 1912, p. 109 (Shansi; Shensi; Kansu). — BEDRIAGA, Wiss. Res. Przewalski Central-Asien Reis., Zool., vol. 3, sect. 1, pt. 4, June, 1912, p. 689 (Ordos).—STANLEY, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 28 (Manchuria; Chihli; Shansi; Kiangsu; Chekiang; Fukien); vol. 47, 1916, p. xiii (Chuchow, Anhui; Paikuhsian, Shansi; Changning, Kiangsi); vol. 50, 1919, p. xv (Kihungshan, S. Honan); p. xvi (Weihaiwei).—GEE, Journ. N. China Asiat. Soc., vol. 50, 1919, p. 184 (Soochow).

Amphiesma tigrinum MOCQUARD, Bull. Mus. Hist. Nat., Paris, 1910, p. 149 (Lanchow, Kansu; Siganfu, Shensi).

Tropidonotus tigrinus lateralis NIKOLSKI, Fauna Rossij, Rept., vol. 2, 1916, p. 40 (Hongkong; Choi-shan, etc.)

In the Herpetology of Japan (p. 278) I expressed the opinion that while in the series of records then (1907) available, namely 62 *N. tigrina* and 20 *N. lateralis*, there was a small gap between the minimum total of ventrals plus subcaudals of 227 in the former, and the maximum of 224 in the latter, "it can hardly be doubted that a larger series would bridge it," and that

consequently it was thought best to use a trinominal appellation for one of them. The additional ten Chinese specimens obtained since then and listed below fail to bridge that gap. However, the slight gap between the subcaudals, namely, 66 minimum in *N. tigrinus* and 64 maximum in *N. lateralis* is bridged by no less than three specimens. Intergradation, as expected, has thus been established, and the use of a trinominal for the Chinese form fully justified.

An additional specimen No. 65942 from Suifu has been sent by Rev. D. C. Graham. The scale formula is: sc. 19; v. 153; a. 2; subc. 57; supral. 7; oc. $2-\frac{3}{4}$; t. 1+2. It will be noted that both Szechwan specimens have one anterior temporal. Moreover, they show the characteristic color and pattern of this subspecies; they have nothing to do with *Natrix handeli* (WERNER).

List of specimens of Natrix lateralis

United States National Museum No.	Sex and age	Locality	When collected	By whom collected	Scale-rows	Ventrals	Anals	Subcaudals	Labials	Oculars	Temporals	Altitude feet
63416		Suifu, Szechwan		D. C. Graham	19	144	1	41+	7			
49637		Shansi, 20 miles southeast of Tai-yuan-fu.		A. deC. Sowerby	19	156	2	66	7	$2-\frac{3}{4}$	1-2	
49638		Shansi, Tai-yuan-fu		do		151	2	62				
39336		Shansi, 70 miles east of Yen-an-fu.		do	19	159	2	57	7	2-3	1-2	3,700
39337		Kansu, near Ho-shin-hsien		do	19	151	2	69	7	2-3	1-2	4,000
39338		do		do	19	157	2	60	7	2-3	1-2	4,000
39339		Shensi, 50 miles east of Yen-an-fu.		do	19	152	2	71	7	2-3	1-2	3,200
39317		Yu-ling-fu, Shensi Chilili		do	19	152	2	57	7	2-3	1-2	4,000
60851		Imp. Hunting Grounds.		do	19	158	2	54				

Genus PSEUDOXENODON Boulenger

1890. *Pseudoxenodon* BOULENGER, Fauna Brit. India, Rept., p. 340 (type, *P. macrops* (Blyth)).

PSEUDOXENODON MACROPS (Blyth)

1854. *Tropidonotus macrops* BLYTH, Journ. Asiat. Soc. Bengal, vol. 23, no. 3, p. 296 (type-locality Darjiling, Himalaya; cotypes in Mus. Calcutta; Capt. W. S. Sherwill, collector). — *Pseudoxenodon macrops* BOULENGER, Fauna Brit. India, Rept., 1890, p. 340 (Eastern Himalaya, etc.); Cat.

Snakes Brit. Mus., vol. 1, 1893, p. 270 (Himalaya, Khasi Hills, Burma).—WERNER, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p. 363 (part: Tatsienlu).—WALL, Proc. Zool. Soc. London, 1903, p. 87 (part: excl. Yunnan).—?STANLEY, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 29 (Fukien); vol. 46, 1915, p. xiii (Kuling).—?MOCQUARD, Bull. Mus. Hist. Nat., Paris, vol. 3, 1897, p. 215 (Tcheku, Upper Mekong Valley, Yunnan).

1858. *Xenodon macrophthalmus* GUENTHER, Cat. Colubr. Snakes Brit. Mus., p. 58 (type-locality; Khasya; Sikkim; Chikiang, China; cotypes in Brit. Mus.; J. Hooker, collector) (part only).—*Tropidonotus macrophthalmus* GUENTHER, Rept. India, 1864, p. 262, pl. 22. fig. *C* (Khasya; Sikkim); Ann. Mus. Zool. St. Pétersbourg, vol. 1, 1896, p. 206 (Tatsienlu, Szechwan).

1871. *Tropidonotus sikkimensis* ANDERSON, Journ. Asiat. Soc. Bengal, vol. 40, pt. 2 (Nat. Hist.) No. 1, p. 17 (type locality, Darjeeling, Himalaya, 5,000 feet alt.; cotypes in Mus. Calcutta).

It may be well here to recapitulate briefly the history of the names of this and related forms, which Guenther at one time embraced under the term of *Xenodon macrophthalmus* or *Tropidonotus macrophthalmus*, and which originally also included specimens of *Tropidonotus himalayanus*.

The first segregation took place in 1864 when Guenther separated the Chikiang,[49] China, specimen from the Fortune collection, as *Tropidonotus dorsalis*,[50] in which he was followed by Boulenger 1890 and 1893 [51] the two forms being distinguishable as follows:

*a*¹. Strongly keeled scales in 19 rows, anteriorly; ventrals, 158–173; subcaudals, 55–75; no black lines on supralabial sutures____**P. macrops.**

*a*². Feebly keeled or smooth scales in 17 rows, anteriorly; ventrals, 140; subcaudals, 51; supralabials with fine black lines at the sutures. **P. dorsalis.**

In the former he included two specimens collected by A. E. Pratt at Kia-ting-fu, Szechwan, 7,070 feet above the sea, already recorded by Guenther [52] as *Tropidonotus macrophthalmus*. But, in 1904, having received additional specimens from Szechwan and Yunnan, he described them as *Pseudoxenodon sinensis*.[53] Expressed in "key" form the characters relied upon to distinguish the three species are now (1904) as follows:

*a*¹. Strongly keeled scales.

*b*¹. Scales anteriorly in 19 rows; ventrals, 160–175; subcaudals, 55–75; supralabials, 8, without sutural black bars; anterior part of belly with dark brown spots____________________________**P. macrops.**

*b*². Scales in 19 or 20 rows on the middle of the body as well as on the neck; ventrals, 144–158; subcaudals, 55–67; supralabials *usually* 7 with sutural black bars; anterior part of belly without dark brown spots____________________________**P. sinensis.**

[49] This, I take it, is the locality in the province of Hupeh; Doctor Werner regards it as equivalent to "Tschekiang," the province of Chekiang.

[50] Rept. Brit. India, 1864, p. 263.

[51] *Pseudoxenodon dorsalis* BOULENGER, Cat. Snakes Brit. Mus., vol. 1, 1893, p. 271, pl. 17, fig. 2.

[52] In Pratt's To Snows of Tibet, 1892, p. 241.

[53] Ann. Mag. Nat. Hist., ser. 7, vol. 13, Feb. 1904, p. 134.

a^2. Scales feebly keeled on the back, smooth on the sides, in 17 rows anteriorly and 15 around the middle of the body; ventrals, 140; subcaudals, 51; supralabials, 8, with fine black lines at the sutures; belly with large brown spots anteriorly ________________ **P. dorsalis.**

Accordingly, *P. sinensis* is like *P. macrops* in the number and keeling of scales, but in number of ventrals and coloration it agrees with *P. dorsalis.* It differs from both in the number of supralabials being usually seven against eight in the other two.

It will be noted that the characters assigned to *P. macrops* are derived from 11 specimens from the Himalayas and Burma; that *P. dorsalis* rests on one specimen presumably from the middle Yangtse; and that five specimens from Szechwan and Yunnan furnish the scale formulas for *P. sinensis.* In addition to the latter Barbour has recorded [54] two specimens, one from Laolingkung, western Szechwan, at 10,300 feet altitude, and one from Yunnanfu, at 6,000 feet, which "come within the range of variation which Boulenger cites for the five previously published specimens". Their ventrals therefore presumably fall within 144–158 with seven supralabials.

In view of the above it is exceedingly puzzling to receive from Rev. D. C. Graham a specimen (No. 66535) collected 50 miles west of Tatsienlu which structurally agrees with *P. macrops* but in color matches *P. sinensis* from the same region. Its scale formula is as follows: sc. 19 (neck and middle, strongly keeled); v. 168; a. 2; subc. 74; l. 8; oc. 1-3; t. 2+3. The coloration is quite characteristic with heavy black sutures to the supralabials, a black chevron mark on the nape, and no spots on the anterior portion of the belly.

With 8 labials and 168 ventrals I do not feel at liberty to dissociate this specimen from *P. macrops.* On the other hand, with the records of 11 specimens of *P. macrops* showing a constant scale formula concomitant with a consistent geographic distribution and 7 specimens of *P. sinensis*, equally constant and consistent, I do not feel justified in reducing the latter to a synonym of the former. It may be, that in the Tatsienlu region the two forms intergrade physically as well as geographically.

PSEUDOXENODON MACROPS SINENSIS (Boulenger)

1892. *Tropidonotus macrophthalmus* Guenther, in Pratt's To Snows of Tibet, p. 241 (Kiating fu, Szechwan; not of 1858).

1904. *Pseudoxenodon sinensis* Boulenger, Ann. Mag. Nat. Hist. (ser. 7), vol. 13, Feb. 1904, p. 134 (type-locality, Yunnan fu, Szechwan; types in Brit. Mus; J. Graham, collector).

Since the account of *Pseudoxenodon macrops* was set in type, the museum has received a specimen (No. 67816) collected by Rev. D. C. Graham at Wenchwan, on the road to Sungpan, Szechwan, which is typical *P. sinensis* in coloration and in the number of ventrals, but with a larger number of subcaudals than recorded for this form

[54] Mem. Mus. Comp. Zoöl., vol. 40, no. 4, 1912, p. 131.

and having seven supralabials on one side and eight on the other. It goes a long way to demonstrate the intergradation of the two forms and justifies the use of the trinominal. It has the following scale formula: Sc. 19; v. 149; a. 2; subc. 70; supral. 7–8.

Genus TAPINOPHIS Boulenger

1899. *Tapinophis* Boulenger, Proc. Zool. Soc. London, 1899, p. 164 (monotype, *T. latouchii* Boulenger).

1909. *Cantonophis* Werner, Jahresh. Ver. Naturk. Württemberg, 1909, p. 57 (monotype, *C. praefrontalis* Werner).

TAPINOPHIS LATOUCHII Boulenger

1899. *Tapinophis latouchii* Boulenger. Proc. Zool. Soc. London, 1899, p. 164, pl. 18, figs. 1–1c (type locality, Kuatun, Fukien, China; type in Brit. Mus.: J. D. La Touche, collector).—Werner, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p. 363 (Kuatun, Fukien).—Wall, Proc. Zool. Soc. London, 1903, p. 87 (China).

1909. *Cantonophis praefrontalis* Werner, Jahresh. Ver. Naturk. Württemberg, 1909, p. 57 (type-locality, Canton, China; type in Mus. Stuttgart).

A single specimen of this very rare and interesting snake (No. 65698) collected at Kuliang, Foochow, on July 25, 1919, has been forwarded by Mr. Sowerby. The specimen is a male, 388 mm. long, tail 80 mm., has 17 scale rows, 165 ventrals, 59 pairs of subcaudals. The only essential point in which it differs from the type is the undivided anal, though the ventral immediately in front of it is divided. It is also slightly abnormal in having nine supralabials on the right side, with the sixth labial only touching the eye, while on the left side there are ten supralabials, sixth and seventh entering eye; the lower postocular is larger and the last three supralabials longer; the single anterior temporal is longer, followed by two smaller ones only half as long. In most other respects it agrees perfectly with Boulenger's original description and figure. The color is nearly uniform dark above, including the labials, and there is no black streak along the side, but the outer scale row is nearly entirely light like the underside, and the scales of the next row have a pale median area and tip. The underside of the tail has no black median streak at the base.

Genus TRIRHINOPHOLIS Boulenger

1893. *Trirhinopholis* Boulenger, Cat. Snakes Brit. Mus., vol. 1, p. 419 (monotype, *T. nuchalis* Boulenger).

TRIRHINOPHOLIS STYANI Boulenger

1899. *Trirhinopholis styani* Boulenger, Proc. Zool. Soc. London, 1899, p. 164, pl. 18, figs. 2–2*a* (type locality, Kuatun, Fukien, China; cotypes in Brit. Mus.; J. D. La Touche, collector).—Werner, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p.. 364 (Kuatun, Fukien).—Wall, Proc. Zool. Soc. London, 1903, p. 88 (China).—Stanley, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 29 (Fukien; Mokanshan, Chekiang); vol. 46, 1915, p. xiii (Kuling).

Of this rare snake Sowerby has sent in one specimen (No. 66434) from Fuchow, Fukien, consequently not far from the type locality, while Graham collected not less than ten specimens, as listed below, at Mount Omei and vicinity, Szechwan. This is rather surprising in view of the fact that the species has been found by no other collector so far in the interior. This series throws considerable light on the individual variation of the species of which formerly only two specimens were on record. As a whole the Szechwan specimens have a slightly shorter head than the one from Fukien before me, but the actual measurements afford no tangible character for separation, and the scale formulas are absolutely identical, and with one exception remarkably uniform, the ventrals in the males ranging between 109 and 116, in the females between 113 and 117, while the subcaudals run respectively 29–30 and 22–26. The one conspicuous exception is the presence of a well developed loreal on both sides in three specimens. In this connection it will be remembered that the type species of the genus, *Trirhinopholis nuchalis* Boulenger, from the mountains of Burma, is also characterized by the presence of a loreal.

List of specimens of Trirhinopholis styani

United States National Museum No.	Sex and age	Locality	When collected	By whom collected	Scale rows	Ventrals	Anal	Subcaudals	Loreal	Oculars	Temporals	Supralabials
64427	Male, adolescent	Mount Omei, Szechwan		Rev. D. C. Graham	15	109	1	30	1	1–2	2+2	6
64429	Female, adolescent.	Mount Omei, Shin Kai Si		do	15	114	1	18	0	1–2	2+2	6
64430	do	do		do	15	116	1	22	0	1–2	2+2	6
64436	Juvenile	do		do	15	113	1	24	0	1–2	2+2	6
65456	Male, adolescent	Mount Omei		do	15	110	1	29	0	1–2	2+2	
65502	Female, adolescent.	do		do	15	118	0	22	0			
65505	do	Mount Omei, Shin Kai Si		do	15	117	1	16	1	1–2	2+2	6
66506	Male, adolescent	do		do	15	110	1	30	1	1–2	2+2	6
66534	Female, adolescent.	do		do	15	117	1	26	0	1–2 1–1	2+2	6
66636	Juvenile	Mount Omei		do	15	117	1	26	0	1–2	2+2	6
66434	Male, adolescent	Foochow, Fukien		A. deC. Sowerby	15	116	1	29	0	1–2	2+2	6

In the arrangement of the temporals there is considerable variation, the large lower first temporal reaching or not reaching the lower postocular. In all, the first pair of lower labials are small and widely separated, the first pair of chin shields being broadly in contact with mental. The coloration is fairly constant, the markings, especially on the neck and labials being more pronounced in the young. The dark nuchal blotch has mostly the same arrowhead shape as in *T. nuchalis.* The characteristic black spot on the rostral is semicircular.

ACHALINUS SPINALIS Peters.

Synonymy in Herpetology of Japan, 1907, p. 297, to which add:

Achalinus spinalis STANLEY, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 29 (Taichowfu, Chekiang); vol. 46, 1915, p. xiii (Kuling).

1889. *Achalinus rufescens* GUENTHER, Ann. Mag. Nat. Hist., ser. 6, vol. 4, Sept. 1889, p. 220 (Ichang, China) (not of Boulenger, 1888); in Pratt's To Snows of Tibet, 1892, p. 240 (Ichang).

1893. *Achalinus braconnieri* BOULENGER, Cat. Snakes Brit. Mus., vol. 1, 1893, p. 309 (Ichang) (not of Sauvage, 1877?).—WALL, Proc. Zool. Soc. London, 1903, p. 88.

1910. *Cochalinus aspinalis* RHUMBLER, Zool. Anz., vol. 34, Dec. 20, 1910, p. 468 (substitute name).

A single halfgrown specimen (No. 66433) from Foochow, Fukien, by Sowerby, seems to prove that Doctor Wall (1903) and myself (1907) were correct in suspecting the distinctness of Boulenger's Chinese *A. braconnieri* from the Japanese species. The color distinction pointed out in the Herpetology of Japan (p. 296), as "the only feature which *thus far* offers a character by which to distinguish the two forms" falls to the ground, as Mr. Sowerby's Fukien specimen has a very distinct black dorsal line and a similar line on the subcaudals, the typical pattern of *A. spinalis.* The scale formula of this interesting specimen is as follows: sc. 23; v. 171; a. 1; subc. 46; oc. 0—0; t. 2+2; l. 6. Internasals are very much shorter than prefrontals, and the chin shields are two on one side and three on the other.

The question whether the Ichang specimens, identified by Boulenger with Sauvage's *Ophielaps braconnieri*, from eastern Kiangsi,[55] really belong to that species is still an open one. His diagnosis certainly does not fit any of the other specimens referred to it.

ENHYDRIS CHINENSIS (Gray)

1842. *Hypsirhina chinensis* GRAY, Zool. Misc. (p. 66) (type locality, China; type in Brit. Mus.; J. R. Reeves, collector).—GUENTHER, Rept. Brit. India, 1864, p. 283 (China).—STEINDACHNER, Novara Exped., Rept., 1867, p. 68 (Hongkong).—MUELLER, Verh. Naturf. Ges. Basel, vol. 6, pt. 4,

[55] See Herp. Japan, 1907, pp. 295–296.

1878, p. 605 (Chong-lok and Silong, Kwangtung prov.).—BOETTGER, Offenbach. Ver. Naturk., 24–25 Ber., 1885, p. 123, p. 151 (Canton).—BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 8, pl. 1, fig. 2 (China; Ichang; Hainan).—WALL, Proc. Zool. Soc. London, 1903, p. 94.—WERNER, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p. 366.

1861. *Hypsirhina dussumieri* FITZINGER, Sitz. Ber. Akad. Wiss., Wien, Math. Nat. Cl., vol. 42, 1861 (p. 406) (Hongkong) (not *Eurostus dussumieri* DUMÉRIL and BIBRON).

1914. *Hypsirhina sinensis* STANLEY, Journ. N. China Asiat. Soc., vol. 45, p. 30 (Fukien) (emendation); vol. 47, 1916, p. xiii (Changning, Kiangsi).

Two specimens from Fukien have been received from Mr. Sowerby, namely, No. 65388 from the Futsing District, and No. 66430, from Foochow. With the latter are two well-developed embryos the color of which is as follows: Ground color pale drab gray with six series of dusky spots: a lower one on angle of each ventral and basal half of first scale row; a lateral series of larger more distinct spots on fifth and sxith or sixth and seventh row; and a median double series on the two scale rows on each side of the vertebral row; the spots form continuous lines on the neck, the median series united into a zigzag band; a dusky band from rostral through eye almost confluent with the lateral neck band.

ENHYDRIS PLUMBEA (Boie)

For synonymy see Herpetology of Japan, 1907, p. 300, to which add:

Hypsirhina plumbea STANLEY, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 30 (Fukien).

Of this widely distributed water snake we have now nine specimens collected by Sowerby in Fukien, namely, two from the Futsing District (Nos. 65386–7), one from near Yenpingfu (No. 65391) and six from Foochow (Nos. 65399–402; 66431–2). C. R. Kellogg also sent us one from Kuliang (No. 64645), and Prof. C. Ping another (No. 66855) from Wenchow, Chekiang.

ENHYDRIS BENNETTII (Gray)

No additional specimen has come to the National Museum since the publication of the Herpetology of Japan, 1907 (p. 307), when a specimen, presumably from Hongkong, was described and figured (figs. 263–265).

ELAPHE RUFODORSATA (Cantor)

For synonymy see Herpetology of Japan, 1907, p. 310, to which add:

Coluber rufodorsatus STANLEY, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 28 (Quixan; Fukien; Chekiang; Kiangsu; Shaweishan Island and Shanhaikwan); vol. 47, 1916, p. xii (Chuchow, Anhui).—GEE, Journ. N. China Asiat. Soc., vol. 50, 1919, p. 184 (Soochow).

Elaphe rufodorsata NIKOLSKI, Fauna Rossij, Rept., vol. 2, 1916, p. 121 (Khingan Mts. etc.).

Of this widely distributed snake which Doctor Stanley says is found practically all over China, the National Museum has received

three specimens from Mr. Sowerby, two collected at Tientsin and one at Hangchow, Chekiang, consequently not far from the type locality of the species. The scale formulas of these specimens are as follows:

U. S. Nat. Mus. No. 52342, fem. ad., Tientsin, sc. 21; v. 177; a. 2; c. 52; l.7; c. 2–2; t. 2+3.

U. S. Nat. Mus. No. 52342, fem. ad., Tientsin, sc. 21; v. . . . ; a. 2; c. 57; l.7; oc. 1–2; t. 2+3.

U. S. Nat. Mus. No. 66463, fem. ad., Hangchow, sc. 21; v. 176; a. 2; c. 52; l.7; oc. 1–2; t. 1+$\frac{3}{3}$.

ELAPHE SCHRENCKII Strauch

Synonymy in Herpetology of Japan, 1907, p. 313, to which add:

Coluber schrenckii Stanley, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 28 (Manchuria, near Sungari Riv.).—*Elaphe schrenckii* Nikolski, Fauna Rossij, Rept., vol. 2, 1916, p. 141 (Khingan Mts., Ussuri, etc.).

1916. *Coluber anomalus* Boulenger, Ann. Mag. Nat. Hist., ser. 8, vol. 17, March, 1916, p. 243 (type locality, Chihfeng, N. E. Chili, China; type in Brit. Mus.; A. L. Hall, collector).

Three specimens have been received from Mr. Sowerby of this somewhat variable snake which apparently reaches a considerable size. One of the specimens is an adolescent male taken in southern Manchuria on the Yalu River about 180 miles from its mouth. Its colors are dark and contrasted, the blackish pattern standing out quite distinct, especially on the ventrals. The two adults, from the Imperial Huntington Grounds in Chilili, 65 miles NE. of Peking, are nearly uniform dark grayish brown above, with indication of the blackish blotches near the posterior end, and pale underside with indistinct brownish-gray mottling. The adolescent specimen lacks the subpreocular on both sides and has a divided anal; the adults have the subpreocular, but in both the anal is single.

From Chifeng, a locality due east from and not more distant than 65 miles from the Imperial Hunting Grounds, Boulenger has described a single specimen as *Coluber anomalus* which he says can only be compared with *C. schrenckii* but differs in the number of upper labial shields (seven against eight in *E. schrenckii*), in the subcaudals being mostly single, and in other points of minor importance. In the Herpetology of Japan (p. 315) I have enumerated one specimen, with seven labials on one side and eight on the other, and one with six labials on one side and seven on the other. With regard to the subcaudals I call attention to the fact that one of Sowerby's Imperial Hunting Grounds specimens (No. 60849) has about ten unpaired subcaudals, and also to Strauch's mention, as a curious anomaly, of a similar condition found only in some east Siberian and West Chinese specimens of *E. dione*. It would therefore seem that the presence of unpaired subcaudals is more or less of a local anomaly among members of the genus *Elaphe* in this region.

List of specimens of Elaphe schrenckii

United States National Museum	Sex and age	Locality	When collected	By whom collected	Scales	Ventrals	Anal	Subcaudals	Labials	Oculars	Temporals
52340	Male, adolescent	South Manchuria, Yalu River		A. deC. Sowerby	23	211	2	68	8	$1-\frac{1}{2}$	2+4
60849	Female, adolescent.	Chilili, Hsin Lung Shan	Aug. 17	do	23	218	1	[a] 66	8	2-2	$\frac{1}{2}+3$
60850	Male, adolescent	do	do	do	23	215	1	70	8	2-2	2+3

[a] Part single.

List of specimens of Elaphe dione

United States National Museum No.	Sex and age	Locality	When collected	By whom collected	Scales	Ventrals	Anal	Subcaudals	Labials	Oculars	Temporals
39318	Female, adolescent.	Shensi, Yu-ling-fu	Nov 19, 1908	A. deC. Sowerby	25	191	2	67	8	$2-\frac{3}{2}$	2+3
49639	Male, adolescent	Shansi, Taiyuanfu	Oct. 17, 1911	do	25	188	2	67	8	2-2	2+4
49641	Juvenile	do	Sept. 28, 1911	do	25	180	2	73	8	2-2	2+4
52338	Male, adolescent	S. Manchuria, Yalu Riv		do	25	185	2	72	8	2-2	2+4

List of specimens of Elaphe taeniurus

United States National Museum No.	Sex and age	Locality	When collected	By whom collected	Scales	Ventrals	Anal	Subcaudals	Labials	Oculars	Temporals
46519	Male, adolescent	Shanghai		D. C. Jansen	23	242	2	107	8	1-2	$\frac{2}{3}+3$
63490	Juvenile	Suifu, Szechwan		D. C. Graham	25	245	2	112	9	2-2	2+3
63595	do	do		do	25	255	2	116	8	2-2	2+3
66457	do	Hangchow, Chekiang		A. de C. Sowerby	25	227	2	96	8	2-2	$2+\frac{3}{4}$
66634	do	Long Kong, Tatsienlu, Szechwan, 11,000 feet altitude.	July 10, 1923	D. C. Graham	23	234	2	111	9	2-2	2+3

ELAPHE DIONE (Pallas)

Synonymy in Herpetology of Japan, 1907, p. 315. to which add:

Coluber (*Elaphis*) *dione* STEINDACHNER, Wiss. Erg. Reise Szechenyi Ost-Asien, vol. 2, 1898, p. 506 (Prov. Szechwan).

Coluber dione BEDRIAGA, Wiss. Res. Przewalski Central-Asien Reis., Zool., vol. 3, sect. 1, pt. 4, June, 1912, p. 696, p. 764 (Ordos; Kansu, etc.).—SOWERBY, in Clark and Sowerby, Through Shen-Kan, 1912, p. 110, pl. (Shensi; Shansi).—STANLEY, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 28 (Quinsan, Chinkiang, Honan, Shantung, Peking and Chinwangtao); vol. 47, 1916, p. xiii (Paikusian, Shansi; Chuchow, Anhui).—GEE, Journ. N. China Asiat. Soc., vol. 50, 1919, p. 184 (Soochow).

Elaphe dione NIKOLSKI, Fauna Rossij, Rept., vol. 2, 1916, p. 122 (Khingan, Ordos, Kansu, etc.).

1910. ?*Zamenis pellioti* MOCQUARD, Bull. Mus. Hist. Nat., Paris, 1910, p. 150 (type-locality, Lanchowfu, Kansu; type in Paris Mus.; Dr. Louis Vaillant, collector).

Four specimens collected by Mr. Sowerby in northern China and Manchuria are typical and fall within the known boundaries of the species both in variation and geographical distribution. The Yalu River specimen is unusually dark and the spots large. For list of specimens see page 82.

ELAPHE TAENIURUS Cope

For synonymy see Herpetology of Japan, 1907, p. 319, to which add:

Coluber (*Elaphis*) *taeniurus* STEINDACHNER, Wiss. Erg. Reise Szechenyi Ost-Asien, vol. 2, 1898, p. 507 (Prov. Szechwan).

Elaphe taeniurus BARBOUR, Mem. Mus. Comp. Zoöl., vol. 40, no. 4, Aug. 1912, p. 129 (Laolingkung, 10,300 feet alt., west Szechwan).—NIKOLSKI, Fauna Rossij, Rept., vol. 2, 1916, p. 139 (Possiet Bay).

Coluber taeniurus STANLEY, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 27 (Shanghai; Soochow, Hangchow, Chinkiang, Anhui, and Fukien); vol. 46, 1915, p. xiii (Kuling); p. xiv (Yaochow, Sze); vol. 47, 1916; p. xiii (Siangtan, Hunan); p. xiv (Suining, Szechwan).—GEE, Journ. N. China Asiat. Soc., vol. 50, 1919, p. 184 (Soochow).

1905. ?*Coluber vaillanti* MOCQUARD, Bull. Mus. Hist. Nat., Paris, 1905, (p. 76) (type-locality, Cao Bang, Tonkin, near Chinese frontier; type in Paris Mus.; Dr. Louis Vaillant, collector); 1910, p. 3, fig. 2.

The scale formulas of the five specimens of this species recently received and recorded on page 82 fall well within the limits established in the Herpetology of Japan (p. 319) for the typical form, except that the maximum for subcaudals is raised to 116 from 111. They also fall within the known geographical limits of the species as restricted by me.

ELAPHE MANDARINUS (Cantor)

1840. *Coluber mandarinus* CANTOR, Zool. Chusan (pl. 12) (type locality, Chusan, China; type in Brit. Mus.; Dr. Cantor collector); Ann. Mag. Nat. Hist., vol. 9, 1842 (p. 483).—GUENTHER, Cat. Colubr. Snakes Brit. Mus., 1858, p. 91; Rept. Brit. India, 1864, p. 238, pl. 20, fig. *H.*— BOETTGER, Offenbach. Ver. Naturk., 24–25 Ber., 1885, p. 147 (Chusan).—BOULENGER, Cat. Snakes Brit. Mus., vol. 2, 1894, p. 42 (Chusan); Proc. Zool. Soc. London, 1899, p. 165 (Kuatun, Fukien).—WALL, Proc. Zool. Soc. London, 1903, p. 91.—WERNER, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p. 364.—STANLEY, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 28 (Kashing; Ningpo; Fukien); vol. 47, 1916, p. xiv (Fukien).—ANGEL, Bull. Mus. Hist. Nat., Paris, 1920, No. 2, p. 112 (Kweichow).

1903. *?Coluber conspicillatus* WERNER, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, p. 357 (Hankow, China) (not of Boie.)

A young specimen (No. 64019) collected by C. H. Barlow at Moh-kan-shan, Chekiang province, was the first specimen of this handsome snake received by the National Museum, perfectly normal in scalation and coloration and well within the known geographic range of the species. Scale formula: sc. 23; v. 213; a. 2; subc. 20+; l. 7; oc. 1–2; temp. 2+3.

The receipt of a fine full grown male (No. 65497) from Rev. D. C. Graham collected at Shin-Kai-Si, Szechwan, on August 31, 1922, was therefore a distinct surprise, as it means a very great extension of the range of the species. The scale formula is as follows: sc. 23; v. 220; a. 2; subc. 70; l. 7; oc. 1–2; temp. 2+3. With regard to the temporals it is to be noted that the second row on one side in both specimens is considerably disarranged by breaking up and fusion. It is further to be noted that while it is doubtful whether the young specimen can be said to possess even an indistinct lateral ventral keel, in the adult specimen there is a very distinct, though obtuse, keel, thus bringing it close to *E. conspicillata*, to which it is undoubtedly related as first suggested by Guenther. Finally, the old specimen, contrary to what is the case in the Japanese species, shows the peculiar color pattern as distinct as the young specimen, except that the red ground color, judging from the appearance in alcohol, is much duller grayish brown, and the dorsal light lozenges are of the same tint as the brownish ground color.

LIOPELTIS MAJOR (Guenther)

Synonymy in Herp. Japan, 1907, p. 338 to which add:

Cyclophis major GUENTHER, in Pratt's To Snows of Tibet, 1892, p. 241 (Kiukiang).

Ablabes major STANLEY, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 27 (Yangtse Valley; Chekiang; Fukien); vol. 46, 1915, p. xiii (Kuling); vol. 47, 1916, p. xiii (Mokanshan).—GEE, Journ. N. China Asiat. Soc., vol. 50, 1919, p. 184 (Soochow).

Liopeltis major BARBOUR, Proc. New England Zoöl. Club, vol. 4, Nov. 1909, p. 69; Mem. Mus. Comp. Zoöl. Cambridge, vol. 40, no. 4, 1912, p. 130 (eight days journey northwest of Ichang).

Mr. Graham has extended the known limit of the green snake in the Yangtse valley, which previously was Ichang, by sending in three spec-

imens (Nos. 64426, 64428 and 66533) from the neighborhood of Mount Omei, at 4,400 feet altitude. While I was writing the Herpetology of Japan, the National Museum had no specimen from China except the type of Hallowell's *Herpetodryas chloris*, from Hongkong. There is now a splendid series of 13 additional specimens, from Fukien (Sowerby), Chekiang (C. H. Barlow), Hunan (Dr. Lewis R. Thompson) and Shanghai (D. C. Jansen), as listed below. The table also shows the remarkable uniformity of the scalation of this species. The most notable exception is No. 66533, an adult female from Mount Omei, which has three postoculars and an undivided anal, the latter being a character of the related species *Liopeltis doriae* (Boulenger), from the Kakhyen Hills and Assam.

All the specimens have a semidivided nasal as stated by Boulenger, and a reexamination of the type of *Herpetodryas chloris* has convinced me that it does not differ essentially from the others.

List of specimens of Liopeltis major

United States National Museum No.	Sex and age	Locality	When collected	By whom collected	Scales	Ventrals	Anal	Subcaudals	Labials	Oculars	Temporals
46520		Shanghai, China		D. C. Jansen	15	167	2	89	8	1-2	1+2
63194	Female, adolescent	Southwestern part of Hunan Province.		Dr. Lewis R. Thompson	15	165	2	85	8	1-2	1+2
63195	Male, adolescent	do		do	15	172	2	88	8	1-2	1+2
63196	Female, adolescent	do		do	15	163	2	86	8	1-2	1+2
63197	do	do		do	15	173	2	92	8	1-2	1+2
63198	do	do		do	15	166	2	85	8	1-2	1+2
64020	Male, adolescent	Moh Kan Shan, Chekiang		C. H. Barlow	15	166	2	87	8	1-2	1+2
64021	Juvenile	do		do	15	167	2	87	8	1-2	1+2
64426	Male, adolescent	Mount Omei, Szechwan Shin-Kai-Si.	1921	D. C. Graham	15	173	2	81	8	1-2	1+2
64428	Female, adolescent	Mount Omei, Szechwan	do	do	15	171	2	84	8	1-2	1+2
65392	Male, adolescent	Yen-ping-fu, Fukien		A. de C. Sowerby	15	166	2	81	8	1-2	1+2
66436	Female, adolescent	Foochow, Fukien		do	15	161	2	80	8	1-2	1+2
66533	do	Shin-Kai-Si, Mount Omei, Szechwan	1923	D. C. Graham	15	167	1	80	8	1-3	1+2

PTYAS KORROS (Schlegel)

To synonymy in Herpetology of Japan, 1907, p. 348, add:

Zamenis korros STANLEY, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 27 (Taichowfu: Chekiang: Fukien; Hainan).

Mr. Sowerby has sent six specimens from Fukien, of which one (No. 65385) is from Futsing, the others (Nos. 65395, 65410–65413) from Foochow.

MASTICOPHIS [56] SPINALIS Peters

For synonymy see Herpetology of Japan, 1907, p. 349 under *Zamenis spinalis*, to which add:

SOWERBY, in Clark and Sowerby, Through Shen-Kan, 1912, p. 110 (Kansu).—BEDRIAGA, Wiss. Res. Przewalski Central-Asien Reis., Zool., vol. 3, sect. 1, pt. 4, June 1912, p. 692 (Alashan; Ordos).—STANLEY, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 27 (Chinwangtao and Peking); vol. 47, 1916, p. xiii (Tsangehow; Prikuhsian, Shansi).—NIKOLSKI, Fauna Rossij, Rept., vol. 2, 1916, p. 81 (Alashan; Ordos).

1910. *?Psammophis schokari* MOCQUARD, Bull. Mus. Hist. Nat., Paris, 1910, p. 151 (Kucha, Sinkiang; oasis of Sachow (not of Forskål).

Two specimens of this apparently rare though widely distributed snake have been sent by Mr. Sowerby. The first, No. 39335, was collected at Tai-pei-cheng, 50 miles west of Ching-yang-fu, Kansu, about 3,900 feet above the sea, on August 15, 1909. Its scale formula is as follows: sc. 17; v. 201; a. 2; subc. 84; l. 8; oc. 2–2; temp. $\frac{1}{2}+2$. The frontal is separated from preocular, and fourth and fifth labials enter the eye. Another, mutilated specimen (No. 59729) without definite locality, but bearing the collector's number 370, has 17 scale rows; eighth labials, fourth and fifth touching eye; two preoculars and two postoculars; temporals 2+3; frontal not in contact with preocular.

Whether the normal number of supralabials in this species is nine or eight, as mentioned in the Herpetology of Japan (p. 351), is still an open question. Noting that the Alashan and Ordos specimens examined by Bedriaga had eight supralabials, it becomes pertinent to inquire whether there may not be a northern form with eight supralabials and a southern one with nine. This is an admonition to place all the data relating to the individual specimens of this species on record.

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[56] In view of the recent revival of the genus *Masticophis* by Professor Ortenburger and as Peters originally described the present species as *Masticophis spinalis*, I have retained this term without prejudice until further studies shall confirm the validity of this genus and establish the propriety of referring the present species to it. The genus *Masticophis* was instituted in 1853 by Baird and Girard, Cat. North Amer. Rept., pt. 1, Serp., p. 98, with *M. flagelliformis* as designated type.

ZAOCYS DHUMNADES (Cantor)

For synonymy see Herpetology of Japan, 1907, p. 352, to which add:

STANLEY, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 27 (Shanghai; Hangchow; Sianfu, Fukien); vol. 47, 1916, p. xiii (Chuchow, Anhui); p. xiv (Kuling); vol. 50, 1919, p. xv (Hwaiyuan).—GEE, Journ. N. China Asiat. Soc., vol. 50, 1919, p. 184 (Soochow).

Of this grass snake, said by Wall and Stanley to be common about Shanghai, the National Museum had no specimen at the time of the publication of the Herpetology of Japan. Thanks to the thoughtfulness of D. C. Jansen we have now a fine adult male of typical coloration and with the typical number of two strongly keeled dorsal scale rows. It has 16 scale rows, 194 ventrals; 2 anals; 109 pairs of subcaudals; 8 supralabials; 2+2 temporals.

ZAOCYS NIGROMARGINATUS (Blyth)

1854. *Coluber nigromarginatus* BLYTH, Journ. Asiat. Soc. Bengal, vol. 23, no. 3, p. 290 (type locality, vicinity of Darjiling, Himalaya; cotypes in Mus. Calcutta; Capt. W. L. Sherwill, collector).

Zaocys nigromarginatus GUENTHER, Rept. Brit. India, 1864, p. pl. 22, fig. B (Nepal; Sikkim; Khasia).—BOULENGER, Cat. Snakes Brit. Mus., vol. 1, 1893, p. 376 (Himalayas, Kasi Hills and Kakhyen Hills, upper Burma).

1858. *Coryphodon carinatus* GUENTHER, Cat. Col. Snakes Brit. Mus., p. 112 (type locality, Borneo, Himalaya, Chusan [57]; cotypes in Brit. Mus.) (part only; Khasia, Sikkim).

1867. *Coryphodon dhumnades* JAN, Icon. Ophid., livr. 23, pl. 4, fig. 1 (Himalaya) (not of Cantor, 1842).

Zaocys dhumnades GUENTHER, Ann. Mus. Zool. St. Pétersbourg, vol. 1, 1896, p. 205 (Lunganfu, Szechwan).

A series of six specimens, adult, adolescent, and young, collected by D. C. Graham in Szechwan, introduce this Himalayan species into the Chinese fauna as distinguished from the Chinese *Z. dhumnades*, for I have but little doubt that the specimen collected by Berezowski at Lunganfu and recorded by Guenther under the latter name is identical with Graham's specimens from Suifu and Mount Omei.

As will be seen from the list given below, the number of subcaudals is in excess of those typical of *Z. dhumnades*. In addition, the number of keeled rows is six in all the specimens, except the youngest one (No. 63414) in which only four scales as keeled, the same as in *Z. nigromarginatus*. Moreover, the color pattern, which is only plainly visible in the younger ones, is that of the latter species as distin-

[57] Restricted by Guenther in 1864, Rept. Brit. India, p. 256, to specimen *a* from Borneo.

guished from *Z. dhumnades*. One of the specimens, No. 63414, is abnormal in lacking the subpreocular on both sides, otherwise the scalation in Mr. Graham's series is normal and very uniform.

With the addition of the one occurring in Formosa, which turns out to be distinct,[58] we have now three forms of *Zaocys* with a single loreal, 16 scale rows and keeled median dorsals as follows:

a[1]. Two (rarely four) median rows of dorsal scales keeled; subcaudals 96–119 pairs.

Z. dhumnades (Cantor).
(Southern China: Fukien to Shanghai, and Yangtse valley to Kiukiang.)

a[2]. Six or four median rows of scales keeled; subcaudals, 117–144 pairs.

b[1]. Subcaudals, 140–144; a yellow vertebral stripe on anterior half of body.

Z. oshimai Stejneger.
(Formosa.)

b[2]. Subcaudals, 117–137; posterior two-thirds of body and tail with a broad black band on each side.

Z. nigromarginatus (Blyth).
(Himalayas to Burma and western Szechwan.)

List of specimens of Zaocys nigromarginatus

United States National Museum No.	Sex and age	Locality	When collected	By whom collected	Scales	Ventrals	Anal	Subcaudals	Labials	Oculars	Temporals
63414	Juvenile	Suifu, Szechwan	Aug., 1920	D. C. Graham	16	198	2	117	8	1–2	2+2
63418	Male, adolescent	do	do	do	16	200	2	126	8	2–2	2+2
64432	Female, adolescent	Mount Omei, Szechwan	1921	do	16	195	2	112	8	2–2	1+2 / 2+2
65498	Male, adolescent	do		do	16	194	2	123	8	2–2	2+2
65499	Female, adolescent	Suifu, Szechwan		do	16	197	2	119	8	2–2	2+2
66644	do	Shin-Kai-Si, Mount Omei, Szechwan	July, 1923	do	16	196	2	119	8	2–2	2+2

[58] **ZAOCYS OSHIMAI, new species.**—1907. *Zaocys dhumnades* STEJNEGER, Herp. Japan, Bull. U. S. Nat. Mus., No. 58, 1907, p. 352 (part, Formosa) (not of Cantor 1842).—OSHIMA, Annot. Zool. Japan., vol. 7, pt. 3, Mar., 1910, p. 195 (Shushu Nanto, Formosa).

Diagnosis.—A single loreal; dorsal scales in 16 rows, (four or ?) six median ones keeled; subcaudals 140–144; coloration a yellow vertebral stripe on two median scales from neck, and a similar one on fifth and sixth scale rows, both disappearing on posterior half of body.

Type locality.—Urai, Island of Formosa.

Type.—U. S. Nat. Mus., No. 52267; Dr. Fred Baker, collector; November 18, 1914.

Scale formula.—Sixteen scale rows, 6 median ones keeled; 201 ventrals; 2 anals; 144 subcaudals; 8 supralabials; 2–2 oculars; 2 + 2 temporals.

Remarks.—This form is closely related to *Z. dhumnades* from the mainland opposite Formosa, having the same color pattern. The scutellation, however, is more like that of *Z. nigromarginatus*, except that the number of subcaudals is even greater than in the latter form.

In three specimens recorded by Dr. M. Oshima, in whose honor this snake is named, the ventrals were 195–197 and subcaudals 140–143. One of the specimens lacked the subpreocular, and another had abnormal temporals.

HOLARCHUS FORMOSANUS (Guenther)

For synonymy see Herp. Japan, 1907, p. 354 (exclusive of reference to *Simotes hainanensis* which is said to be a recognizable color form).

Mr. Sowerby has sent a typical example of this species from near Yenpingfu, Fukien (No. 65393) which has the following scale formula: sc. 19; v. 158; a. 1; subc. 47; lab. 8; oc. 2–2; temp. 1+2.

HOLARCHUS VIOLACEUS (Cantor)

1839. *Coronella violacea* CANTOR, Proc. Zool. Soc. London, 1839, p. 50 (type locality, Rungpore, Bengal).
Simotes violoceus BOULENGER, Fauna Brit. India, Rept., 1890, p. 312 (Bengal to Southern China); Cat. Snakes Brit. Mus., vol. 2, 1894, p. 222 (Bengal to southern China; Amoy; Hongkong).—WALL, Proc. Zool. Soc. London, 1903, p. 92 (mainland opposite Hongkong).—WERNER, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p. 365.—STANLEY, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 27 (Hainan; Fukien).
Holarchus violaceus STEJNEGER, Herp. Japan, Bull. U. S. Nat. Mus. No. 58, 1907, p. 354
1864. *Simotes cinereus* GUENTHER, Rept. Brit. India, p. 215 (type locality, Cambodja; type in Brit. Mus.; Mr. Mouhot, collector).
1864. *Simotes swinhonis* GUENTHER, Rept. Brit. India, p. 215, pl. 20, fig. *E* (type locality, Amoy, China; types in Brit. Mus.; R. Swinhoe, collector.).—MUELLER, Verh. Naturf. Ges. Basel, vol. 6, pt. 4, 1878, p. 595 (Lilong, Kwangtung).
1865. *Simotes multifasciatus* JAN, Icon. Gen. Ophid., livr. 12, pl. 4, fig. 2 (type locality?).
1871. *Simotes semifasciatus* ANDERSON, Journ. Asiat. Soc. Bengal, vol. 40, pt. 2, Nat. Hist., p. 16 (type locality, Naga Hills, Assam; cotypes in Ind. Mus., Calcutta).
1885. *Simotes swinhoei* BOETTGER, Offenbach. Ver. Naturk., 24–25 Ber., 1885, p. 146 (Lilong; Amoy) (emendation).
1895. *Holarchus dolleyanus* COPE, Proc. Acad. Nat. Sci. Philadelphia, 1894, p. 423, pl. 10, fig. 1 (type locality, Hainan; Rev. F. Gilman, collector).

A specimen (No. 65396) was collected by Mr. Sowerby at Foochow, Fukien, which has the following scale formula: sc. 17; v. 157; a. 1; subc. 37; lab. 8; oc. 2–2; temp. 2+2.

It will be noted that there are two well developed anterior temporals on both sides, but fourth and fifth supralabials enter the eye and in all other characters the specimen is a typical *H. violaceus*.

DINODON RUFOZONATUM (Cantor)

Synonymy, Herpetology of Japan, 1907, p. 358, to which add:
Lycodon rufozonatus STANLEY, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 26 (Shanghai; Soochow; Wusich; Kiukiang; Tatung; Anhui; Szechwan; Fukien; Ningpo; Tsinanfu; Peking); vol. 47, 1916, p. xiii (Tsangchow); p. xiv (Kashing; Suining; Szechwan; p. xv (Kuling); vol. 48, 1917, p. xiii (Pingchiao Quarry).—GEE, Journ. N. China Asiat. Soc., vol. 50, 1919, p. 184 (Soochow).

To the known localities where this common and widely distributed snake occurs may be added southwestern part of Hunan (Nos. 63201–2, collected by Dr. Lewis R. Thompson) and Suifu, Szechwan (No. 63415 by Rev. D. C. Graham) and Hangchow, Chekiang (No. 66458 by A. de C. Sowerby). D. C. Jansen has also sent us two specimens from Shanghai (Nos. 46517–46518).

Genus LYCODON Boie

1826. *Lycodon* Boie, Ferussac's Bull. Sci. Nat., 1826, p. 238 (type, *Coluber aulicus* Linnaeus).[59]

1830. *Ophites* Wagler, Syst. Amph., p. 186 (monotype, *Lycodon subcinctus* Boie).

1853. *Sphecodes* Duméril and Bibron, Mém. Acad. Sci., Paris, vol. 23, p. 461, author's separate, p. 65 (monotype *S. albofuscus*).

1858. *Leptorhytaon* Guenther, Cat. Colubr. Snakes Brit. Mus., p. 205 (monotype, *Leptorhytaon jara*).

1858. *Tetragonosoma* Guenther, Cat. Colubr. Snakes Brit. Mus., p. 253 (monotype, *Lycodon effraenis* Cantor).

1868. *Tytleria* Theobald, Cat. Rept. Asiat. Soc. Bengal Mus., (p. 66) (type, *T. hypsirhinoides* Theobald).

1893. *Anoplophallus* Cope, Amer. Natural., 1893, p. 480; Trans. Amer. Philos. Soc., vol. 18, pt. 2, 1895, p. 216. (Type, *A. maculatus* Cope).

LYCODON SUBCINCTUS Boie

1827. *Lycodon subcinctus* Boie, Isis, 1827, p. 551 (type locality, Java).—Boulenger, Cat. Snakes Brit. Mus., vol. 1, 1893, p. 359.—Wall, Proc. Zool. Soc. London, 1903, p. 88 (Hongkong).

1860. *Homalopsis buccatus* Hallowell, Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 504 (Hongkong Island) (not of Linnaeus).

1884. *Elapoides annulatus* Sauvage, Bull. Philom. Paris, ser. 7, vol. 8, (p. 144) (type locality, Sumatra; type in Paris Mus.; P. Fauque, collector).

1895. *Anoplophallus maculatus* Cope, Trans. Amer. Philos. Soc., vol. 18, pt. 2, p. 216, pl. 26, fig. 2 (not *Megalops maculatus* Hallowell, 1860).

The National Museum has not received any additional material of this species, but I wish to place on record, U. S. Nat. Mus. No. 7359, which is the specimen mentioned by Hallowell (Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 504) under the name " ? *Homalopsis buccatus* " as collected " on the Island of Hong Kong, May, 1854,

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[59] Type designation by Fitzinger, Neue Class. Rept., 1826, p. 29, p. 30. See Stejneger, Proc. U. S. Nat. Mus., vol. 38, 1911, p. 107.

by Mr. Brooke, of the North Pacific Exploration under command of Capt. John Rogers, U. S. N."

In connection with this specimen another error should be corrected. It is the same specimen which Cope introduced as the type of a new genus, *Anoplophallus*, to be known as *A. maculatus*, under the mistaken notion that it was the type of Hallowell's *Megalops maculatus*, which apparently has been lost. The blunder is manifest by examining Hallowell's description of the generic characters, among which "a frenal; two antoculars," etc., while Cope himself correctly (for *Lycodon subcinctus*) says "a long loreal and no preocular plate."

What Hallowell's *Megalops maculatus* from Tahiti really represents is still a mystery, but Cope's *Anoplophallus maculatus* is undoubtedly a synonym of *Lycodon subcinctus*.

LYCODON AULICUS (Linnaeus)

1758. *Coluber aulicus* LINNAEUS, Syst. Nat., ed. 10, vol 1, p. 220 (type locality, "America"; type in Mus. Adolph. Fred.) : ed. 12, vol. 1, 1766, p. 381.—ANDERSON, Bih. Svensk. Vet. Akad. Handl., vol. 24, pt. 4, no. 6, 1899, p. 16 (type).

Lycodon aulicus FITZINGER, Neue Classif. Rept., 1926, p. 57.—STEINDACHNER, Reise Novara, Rept., 1867, p. 74 (Amoy).—BOETTGER, Offenbach. Ver. Naturk., 26–28 Ber., 1888, p. 84 (Hongkong).—BOULENGER, Cat. Snakes Brit. Mus., vol. 1, 1893, p. 352.—WALL, Proc. Zool. Soc. London, 1903, p. 88 (Hongkong? Amoy?).—WERNER, Abh. Bayer. Akad. Wiss., II Kl, vol. 22, pt. 2, 1903, p. 364 (Hongkong).—STEJNEGER, Herp. Japan, Bull. U. S. Nat. Mus., no. 58, 1907, p. 358.

The doubt as to the occurrence of this species in southern China voiced by Doctor Wall in 1903 has not been entirely removed, though I still think that the specimen in the Hongkong Museum credited to Formosa is in reality from Hongkong,[60] if Chinese at all.

CALAMARIA SEPTENTRIONALIS Boulenger

1888. *Calamaria quadrimaculata* GUENTHER, Ann. Mag. Nat. Hist. (ser. 6), vol. 1, 1888 (p. 165) (Mts. N. of Kiukiang) (not of DUMÉRIL and BIBRON, 1854); in Pratt's To Snows of Tibet, 1892, p. 239.

1890. *Calamaria septentrionalis* BOULENGER, Proc. Zool. Soc. London, 1890, p. 34 (type locality, Kiukiang and Hongkong, China; cotypes in Brit.

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[60] See Herp. Japan, p. 358.

Mus.; A. E. Pratt, collector); Cat. Snakes Brit. Mus., vol. 2, 1894, p. 349, pl. 20, fig. 1 (Mts. N. of Kiukiang, Hongkong, Chusan Archip., and mainland opposite); Proc. Zool. Soc. London, 1899, p. 165 (Kuatun, Fukien).—Wall, Proc. Zool. Soc. London, 1903, p. 93.—Werner, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p. 365.—Stanley, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 26 (Wuhu; Weichow; Fukien).

The series of seven specimens now in the National Museum, thanks to Dr. Louis R. Thompson, C. H. Barlow, and A. deC. Sowerby extends the known range of this species to southwestern Hunan. It consequently embraces all of southeastern China south of the Yangtse and up that river as far as Kiukiang.

Our series shows great uniformity both in structure and color. The scale formulas may be seen from the table below, which show no deviation from those given previously by Boulenger for ten specimens, except that the maximum for the subcaudals of the males is raised from 17 to 18. The snout in all is blunt, with the rostral barely visible from above. The coloration in all the specimens agrees closely with the figure given by Boulenger.

It will thus be seen that the characters relied upon in the Herpetology of Japan (p. 376) for the separation of *Calamaria berezowskii*, from Szechwan and Formosa, are fully confirmed by the present series of *C. septentrionalis* to which it is probably intimately related. The curious fact that several of the Formosan species show greater similarity to species from Szechwan and the Himalayan region than to those of the intermediate region is thus emphasized.

List of specimens of Calamaria septentrionalis

United States National Museum No.	Sex and age	Locality	When collected	By whom collected	Scale rows	Ventrals	Anal	Subcaudals	Supralabials
63191	Female, adolescent	Southwest part of Hunan Province, China		Dr. Lewis R. Thompson	13	171	1	9	4
63192	Male, adolescent	do		do	13	154	1	17	4
63193	do	do		do	13	158	1	17	4
64016	do	Moh Kan Shan, Chekiang, China		C. H. Barlow	13	161	1	18	4
64017	Female, adolescent	do		do	13	174	1	10	4
64018	do	do		do	13	174	1	10	4
65414	Male, adolescent	Foochow, Fukien		A. deC. Sowerby	13	156	1	18	4

Family BOIGIDAE

PSAMMODYNASTES PULVERULENTUS (Boie)

For synonymy see Herpetology of Japan, 1907, p. 383, to which add:
Psammodynastes pulverulentes STANLEY, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 29 (Hainan; Fukien).

In 1910 when discussing the relationship of the Formosan reptilian fauna to that of the Philippine archipelago[61] I stated that there were only two species common to Formosa and the Philippines which had not yet been collected in Chinese territory, namely *Dasia smaragdina*, a skink of wide distribution and likely to have been introduced into Formosa by human agency, the other being the snake here under consideration. With regard to *P. pulverulentus* I then remarked that its discovery within the limits of China would not cause surprise as its known distribution includes Assam, Sikkim, and the Shan states. This prophecy was fulfilled within four years, for in 1914 Mr. Stanley recorded specimens both from north and south Fukien, and from Hainan.

Further confirmation is had through a specimen (No. 65394) collected by Mr. Sowerby near Yenpingfu, Fukien.

Family AMBLYCEPHALIDAE

AMBLYCEPHALUS CHINENSIS Barbour

1912. *Amblycephalus chinensis* BARBOUR, Mem. Mus. Comp. Zoöl., vol. 40, no. 4, August 1912. p. 132, pl. 2, fig. 1 (type-locality, Luluping, western Szechwan; type, Mus. Comp. Zoöl., no. 7326; W. R. Zappey).—STANLEY, Journ. N. China Asiat. Soc., vol. 47, 1916, p. xiii.

A specimen with a badly mutilated head, (no. 67815) was collected by Mr. Graham 50 miles northwest of Kuanshien, Szechwan, on the road to Sungpan, 1924. The scale formula is as follows: sc. 15; v. 176; a. 1; subc. 74. The head is so badly crushed that the separate shields can not always be made out with certainty.

Family ELAPIDAE

NAJA NAJA ATRA (Cantor)

For synonymy see Herpetology of Japan, 1907, p. 394, to which add:
Naia naia atra BARBOUR, Proc. New England Zoöl. Club, vol. 4, 1909, p. 72 (Hainan).—STANLEY, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 30 (Taichowfu, Wenchow, Chekiang; Kuatun and Ningteh, Fukien; Lammock Islands); vol. 47, 1916, p. xiv (Pagoda Anchorage, Foochow); vol. 50, 1919, p. xv (Hongkong).

A head (No. 16284) of a specimen from Wenchow, Chekiang, by Dr. D. J. MacGowan, and an adult (No. 63190) collected by Dr.

[61] Proc. U. S. Nat. Mus., vol. 38, 1910, p. 94.

Lewis R. Thompson in the southwestern part of Hunan are now in the collection in addition to the Hongkong specimen listed in the Herpetology of Japan. The scale formula of the Hunan specimen is as follows: sc. on neck 25, on body 21; v. 167; a. 1; c. 49; l. 7; oc. 1–$\frac{2}{3}$; temp. 2+2. It will be seen that the sum of ventrals and subcaudals is 216, exactly the average of the nine specimens previously listed by me.[62]

BUNGARUS MULTICINCTUS Blyth

For synonymy see Herpetology of Japan, 1907, p. 397, to which add:

Bungarus caeruleus multicinctus BARBOUR, Mem. Mus. Comp. Zoöl., vol. 40, no. 4, 1912, p. 131 (Ichang, Hupeh).

Bungarus semifasciatus STANLEY Journ. N. China Asiat. Soc., vol. 45, 1914, p. 30 (South China).

Bungarus candidus STANLEY, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 30 (Chekiang and Fukien); vol. 47, 1916, p. xiv (Ningteh, Fukien).

Four specimens have been recently added to the national collection, two (Nos. 63199–200) from the southwestern part of the province of Hunan by Dr. Lewis R. Thompson, one (No. 64646) from Kuliang by C. R. Kellogg, and one (No. 65408) from Foochow, Fukien, by Mr. Sowerby. The number of black rings on body and tail is respectively 54, 47, 59, and 58, showing that the specimens are of the normal pattern of this form.

DISTEIRA CYANOCINCTA (Daudin)

For synonymy see Herpetology of Japan, 1907, p. 428, to which add:

Distira cyanocincta WALL, Mem. Asiat. Soc. Bengal, vol. 2, no. 8, 1909, p. 217.

Disteira cyanocincta STANLEY, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 30 (Foochow, Fukien).

Lioselasma cyanocincta WALL, Snakes of Ceylon, 1921, p. 361.

A single specimen (No. 46521) from Shanghai has been presented by D. C. Jansen.

Family CROTALIDAE

Genus AGKISTRODON Beauvois

In the Herpetology of Japan (p. 450) I referred to the "small compact group consisting of the species *Agkistrodon halys*, *blomhoffi* and *himalayanus* occupying the vast territory from the Kaspian Sea in the west to the Pacific Ocean in the east, and from Lake Baikal in the north to the Hamalayas in the south" as being "closely interrelated, in fact so nearly allied that their descent from a common ancestor can not have taken place at a very distant period." With regard to the nomenclatorial treatment of these

[62] Herpetology of Japan, p. 397.

snakes, particularly *A. halys* and *A. blomhoffi*, the latter being the only form occurring in the territory treated of, I expressly stated that "to what extent the turning up of the end of the snout may serve *in all instances* as a character to separate *A. halys* I can not say for lack of material, and for that reason I shall *at present* treat the latter as a good species."

The doubts as to the specific distinctness of these forms, first hesitatingly expressed by Guenther in 1896, have since been justified by the investigations of Bedriaga, 1912, and of Nikolski, 1916, who have had access to an unsurpassed material of Central and East Asiatic specimens.[63] Bedriaga,[64] particularly, demonstrated the intergradation between *A. halys* and *A. intermedius*, though as a binominalist he treats them nomenclatorially as species, but as I had already (1907) shown the intergradation between *A. intermedius* and *blomhoffi*, Nikolski who on the contrary is a thoroughgoing trinominalist, accepted the nomenclatorial consequences and enumerated the various forms, including a new one described by him, as *A. halys halys*, *A. halys caucasicus*, *A. halys intermedius*, *A. halys brevicaudus*, and *A. halys blomhoffi*.[65] Both Bedriaga and Nikolski tried to introduce new criteria for the discrimination of these forms, the former mentioning the width of the rostral at the apex, the latter the relative width of the anterior and posterior nasals, which, when other characters fail, may be of assistance in dubious cases. Bedriaga also described a new species from western China as *A. strauchi* and essayed the following key (pp. 732-733):

a^1. Large posterior supralabials; height of fifth supralabial equals length of free edge of third supralabial; rostral somewhat turned over above; canthus rostralis not marked____________________**A. strauchi.**

a^2. Small or medium posterior supralabials; height of fifth supralabial less than the length of the free edge of third supralabial; rostral not turned over onto the upper surface of head; canthus rostralis distinctly or sharply prominent.

  b^1. Width of upper, strongly narrowed part of rostral, measured at the level of the suture between internasals and nasals, equals half the length of suture between anterior nasal and rostral______ _**A. halys.**

[63] Nikolski, for instance, had 173 specimens of *A. intermedius* and 48 of *A. halys*.

[64] Wiss. Res. Przewalski Central-Asien Reis., Zool., vol. 3, sect. 1, pt. 4, 1912, pp. 719–726.

[65] During the same year, 1916, Dr. J. C. Thompson (Trans. San Diego Soc. Nat. Hist., vol. 2, no. 2, 1916, pp. 61–76) attempted by the statistical method to reduce these various forms to synonyms of *A. halys*, but by bunching his figures under such geographic headings as Korea, China, mainland specimens, and island specimens, etc., without giving detailed data by individuals, he failed to bring out the significant facts associated with the geographical distribution of the variations observed by him.

b^2. Width of upper, narrow part of rostral, measured at the level of the suture between internasals and nasals, greater than half the length of suture between anterior nasal and rostral.

c^1. Distance from lower end of suture between upper loreal and upper preocular to point of lower preocular wedged in between second and third supralabials equals height of third supralabial; width of rostral at the level of the suture between first supralabial and anterior nasal as great as or somewhat greater than the distance from eye to nostril__________**A. blomhoffii.**

c^2. Distance from lower end of suture between upper loreal and upper preocular to point of lower preocular, wedged in between second and third supralabials, distinctly less than height of third supralabials; width of rostrals, at level of suture between first supralabial and anterior nasal, less than distance from eye to nostril____________________________________**A. intermedius.**

Nikolski, omitting *A. strauchi* as not being included in the Russian fauna, amended the key given in the Herpetology of Japan, in the following manner (p. 267, misprints corrected):

a^1. Ventrals 151, or more.

b^1. Scales in 23–25 rows; anterior nasal somewhat larger than posterior.

c^2. Subralabials 7__________________________**A. halys caucasicus.**

c^1. Supralabials 8, rarely 7_____________________**A. halys halys.**

b^2. Scales in 21–23 rows; anterior nasal at least twice as large as posterior_________________________________**A. halys intermedius.**

a^2. Ventrals 151, or less.

b^1. Subcaudals 44 or more______________________**A. halys blomhoffii.**

b^2. Subcaudals 46 or less______________________**A. halys brevicaudus.**

If the specimens, the unquestioned and detailed data of which have been recorded, were plotted on a map of Asia, it would be found that the individuals identified according to the above keys group themselves geographically in such a manner as to justify their recognition nomenclatorially. The number of specimens which deviate from the normal of each region is not greater than in most other cases of intergrading variable superspecies of wide distribution.

AGKISTRODON HALYS INTERMEDIUS (Strauch)

Agkistrodon blomhoffii intermedius Stejneger, Herp. Japan, Bull. U. S. Nat. Mus., No. 58, 1907, p. 464.—Barbour, Proc. New England Zoöl. Club, vol. 4, No. 1909, p. 73 (Mt. Taipaishiang, Shensi).

Ancistrodon intermedius Sowerby in Clark and Sowerby, Through Shen-Kan, 1912, p. 110 (Shansi).—Bedriaga, Wiss. Res. Przewalski Central-Asien Reis., Zool., vol. 3, sect. 1, pt. 4, June 1912, p. 713, pl. 10, figs. 2–2*a*, 6–6*b* (Alashan; Ordos; Kansu).—Tschugunow, Ann. Mus. Zool. St. Pétersbourg, vol. 17, 1913, (p. 255) (Minussinsk).

Ancistrodon halys intermedius Nikolski, Fauna Rossij, Rept., vol. 2, 1916, p. 276 (Mongolia, Gobi, Ussuri etc.).

The records published and specimens received since the publication of the Herpetology of Japan bear out the general statement made there regarding this form. Thus Bedriaga records 14 specimens from Alashan, Ordos, and Kansu with ventrals between 152 and 180; Tschugunow mentions 6 specimens from Minusinsk with ventrals between 158 and 174 (average 164); Barbour reports two specimens from Shensi having 157 and 161 ventrals. Sowerby sent a typical specimen (No. 49640), with scale formula: 23 sc.; 147 v.; 45 subc.; 7/8 lab., collected on September 29, 1911 at a locality 15 miles west of Tai-yuan-fu, Shansi, altitude about 5,000 feet, and one (No. 53365) from I-mien-po, North Kirin, Manchuria, with a scale formula of 21 sc.; 152 v.; 48 subc.; and 7 lab.

AGKISTRODON HALYS BREVICAUDUS (Stejneger)

Agkistrodon blomhoffii brevicaudus STEJNEGER, Herp. Japan, Bull. U. S. Nat. Mus., No. 58, 1907, p. 463.—BARBOUR, Mem. Mus. Comp. Zoöl., vol. 40, no. 4, Aug. 1912, p. 132, (Ichang and Kweichowhsien, Hupeh).

Halys blomhoffii GUENTHER in Pratt's To Snows of Tibet, 1892, p. 242 (near Kiukiang).

Ancistrodon blomhoffii STANLEY, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 31 (Shanghai; Soochow, Hankchow, Wusich, Chinkiang and Tatung in Anhui).

Agkistrodon blomhoffii brevicaudatus BARBOUR, Mem. Mus. Comp. Zočl., vol. 40, no. 4, Aug. 1912, pl. 2, fig. 2 (emendation).

Ancistrodon blomhoffii brevicaudus NIKOLSKI, Ann. Zool. Mus. St. Pétersbourg, vol. 19, 1914 (p. 90) (Ussuri).

Ancistrodon halys brevicaudus NIKOLSKI, Fauna Rossij, Rept., vol. 2, 1916, p. 283 (Hongkong; Korea).

A considerable material has accumulated since the publication of the Herpetology of Japan, which throws further light on the vexing question of the distinctness of *A. brevicaudus*, *A. intermedius* and *A. blomhoffii.* The specimens collected by Sowerby in northern China are of special interest, particularly a series of 10 specimens from the Hsin-Lung-Shan district, Imperial Hunting Grounds, Chilili. They all have 21 scale rows, 136–144 ventrals (average 140), 35–40 subcaudals (average 39) and 7 labials, and are consequently all well within the limits set for *A. brevicaudus*, less than 151 ventrals and less than 46 subcaudals. Specimens from further south in eastern China, as the two by L. I. Moffett from Kiangyin, province of Kiangsu, and the one by C. H. Barlow from Wan Wang Shan, Chekiang, which have 21 scale rows, 7 labials, ventrals 136–140 and subcaudals 37–41, are of course equally typical. So are Barbour's Hu-

peh specimens: 21 sec.; 141–145 v.; 35–39 subc.; 7 lab. It is along the northern boundary between *A. brevicaudus* and *A. intermedius* that we expect and, indeed, find intermediate specimens. Thus Mr. Sowerby collected two specimens (Nos. 52339 and 52341) in southern Manchuria on the Yalu river, the boundary against Korea, about 180 miles from its mouth. Both have 21 scale rows and 7 labials, negative characters but in case of doubt pointing towards *A. brevicaudus* rather than *A. intermedius;* one has 143 ventrals and 41 subcaudals, well within the limits of *A. brevicaudus*. But the other one, which it would be absurd to refer to under a different sub-specific name, has 151 ventrals and 44 subcaudals. On page 452 of the Herpetology of Japan I said that "it would be impossible to say to which of the three forms (*brevicaudus* or the two forms of *intermedius*) a specimen with 151 ventrals and 45 subcaudals were to be referred unless it had 8 supralabials in which case it should probably be referred to *intermedius.* In the present instance, however, I have no hesitation in calling it *A. brevicaudus*, the decisive factor of course being the fact that its companion is typical of this form. Were it not for these dubious intermediate specimens in the geographically intermediate territory we would be justified in applying a binominal appellation rather than the present trinominal.

AGKISTRODON STRAUCHI Bedriaga

1912. *Ancistrodon strauchi* BEDRIAGA, Wiss. Res. Przewalski Central-Asien Reis., Zool., vol. 3, sect. 1, pt. 4, June 1912, p. 728, pl. 10, figs. 1–1*d* (type locality, Tungolo and Tatsienlu, Szechwan, China; cotypes, Petrograd Mus. Nos. 8533–8534; Potanin, collector).

1912. *Agkistrodon tibetanus* BARBOUR, Mem. Mus. Comp. Zoöl., vol. 40, No. 4, August, 1912, p. 133, pl. 2, figs. 3–4 (type locality, Ramala Pass beyond Tatsienlu, western Szechwan, 13,000 feet; type, Mus. Comp. Zoöl., no. 7327; W. R. Zappey, collector).

Of this recently described remarkable species, as yet very rare in collections, Mr. Graham has sent three fine specimens collected in July, 1923, at Ngan Yang, western Szechwan, at an altitude between 13,000 and 14,000 feet. This locality is evidently not far from the type localities of *A. strauchi* and *A. tibetanus*. Apparently the species is of very restricted distribution and is possibly limited to the high plateau of eastern Tibet above 13,000 feet altitude.

List of specimens of Agkistrodon halys brevicaudus

United States National Museum No.	Sex and age	Locality	When collected	By whom collected	Scale rows	Ventrals	Subcaudals	Labials
52339	Female, adolescent	Yalu River, South Manchuria		A. deC. Sowerby	21	151	44	7
52341	Male, adolescent	do		do	21	143	41	7
52559	Juvenile	Kiangyin, Kiangsu		L. I. Moffett	21	140	41	7
52560	do	do		do	21	138	40	7
60852	Male, adolescent	Imp. Hunting Ground, Chilili	Aug. 1917	A. deC. Sowerby	21	140	41	7
60853	Female, adolescent	do	do	do	21	144	37	7
60854	Male, adolescent	do	do	do	21	142	36	7
60855	do	do	do	do	21	144	43	7
60856	Female, adolescent	do	do	do	21	140	36	7
60857	Male, foetus	do	do	do	21	137	44	7
60858	Female, foetus	do	do	do	21	139	36	7
60859	Male, foetus	do	do	do	21	140	41	7
60860	do	do	do	do	21	136	41	7
60861	Female, adolescent	do	do	do	21	136	35	7
64015	Juvenile	Wan Wang Shan, Chekiang		C. H. Barlow	21	136	37	7

List of specimens of Agkistrodon strauchi

Museum	No.	Sex and age	Locality	When collected	By whom collected	Scales	Ventrals	Subcaudals	Labials
United States National	66631	Female, adolescent	Ngan-Yang, Szechwan	July, 1923	D. C. Graham	21	160	38	7
Do	66632	Male, adolescent	do	do	do	21	152	37	7
Do	66633	do	do	do	do	23	152	43	7
Petrograd	8533	Adolescent	Tungolo		Potanin	21	149	44	7
Do	8534	do	Tatsienlu, Szechwan		do	21	161	44	6
Comp. Zoöl., Cambridge	7327	do	Ramala Pass, Szechwan		W. R. Zappey	21	152	43	7

AGKISTRODON ACUTUS (Guenther)

For synonymy see Stejneger, Proc. U. S. Nat. Mus, vol. 38, 1910, p. 112, to which add:

Ancistrodon acutus Boulenger, Proc. Zool. Soc. London, 1899, p. 166 (Kuatun, Fukien).—Wall, Proc. Zool. Soc. London, 1903, p. 98 (Yangtse Valley).—Stanley, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 31 (Fukien).

The National Museum is indebted to C. H. Barlow for a fine male (No. 64024) of this remarkable copperhead from Moh-Kan-Shan, Chekiang Province. The scale formula is as follows: sc. 21; v. 161; a. 1; subc. 65, of which the first eight are single, the others divided; l. 7; oc. 3–2; temp. 2+4; rostral undivided; lower postocular extending under the eye and meeting anteriorly a small subpreocular, thus separating the eye from the supralabials.

TRIMERESURUS MUCROSQUAMATUS (Cantor)

For synonymy see Herpetology of Japan, 1907, p. 467, to which add:

Stanley, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 31 (Fukien).

A young specimen (No. 63417) collected by Rev. D. C. Graham at Suifu, Szechwan, furnishes a welcome opportunity to examine into the identity of the Formosan representative of this poisonous snake and the mainland form. It will be recalled that the type of *T. mucrosquamatus* which came from Naga Hills, Assam, has been lost and that, as no specimens from that locality had been recorded since, doubt had been raised as to the title of the Formosan snakes to the name given by Cantor. Since then Mr. Stanley has recorded specimens from Fukien, but apparently no comparison has been instituted.

There can scarcely be any doubt that the Szechwan specimen is entitled to the name. On the other hand, it is a very young specimen, and the two Formosan specimens at my disposal are full grown. That may account for the different shape of the head which is much shorter in the Szechwan specimen. The only other difference of any consequence which I have found is that in the Szechwan specimen the number of scale rows between the subocular and the supralabials is four while in the Formosan ones there are only three and two. The very variation of this character in the island specimens, however, would seem to indicate that this difference is of no importance. The scale formula otherwise falls within the limit established for the Formosan specimens, viz., sc. 27; v. 205; subc. 77; l. 10. There are about 17 small scales in a row between the supraoculars, but Dr. Oshima,[66] has recorded 14 to 18 in Formosan examples.

[66] Annot. Zool. Japon., vol. 17, pt. 3, 1910, p. 206.

Since the above was set in type Mr. Graham has sent another specimen (No. 67778), also quite young, collected at Wanchan. It agrees with the one described above, but has only three rows of scales between subocular and supralabials, and about 13 between supraoculars. Sc. 25; v. 209; subc. 88.

TRIMERESURUS JERDONII Guenther

1875. *Trimeresurus jerdonii* GUENTHER, Proc. Zool. Soc. London, 1875, p. 233, pl. 34 (type locality, Khasi Hills, Assam; cotypes in Brit. Mus.; T. C. Jerdon, collector).—BOULENGER, Fauna Brit. India, Rept., 1890, p. 427 (Khasi Hills; Ichang, China).

Lachesis jerdonii BOULENGER, Cat. Snakes Brit. Mus., vol. 3, 1896, p. 551 (Assam; Kiatiangfu, Szechwan; Ichang).—WALL, Proc. Zool. Soc. London, 1903, p. 99.—WERNER, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p. 367.

1889. *Trimeresurus xanthomelas* GUENTHER, Ann. Mag. Nat. Hist., ser. 6, vol. 4, Sept. 1889, p. 221 (type locality, Ichang, China; cotypes in Brit. Mus.; A. E. Pratt, collector); in Pratt's To Snows of Tibet, 1892, p. 241, pl. 1, fig. *A* (Ichang).

A splendid specimen (No. 64639) of this rare species was collected by Rev. D. C. Graham at Si-Gi-Pin, Mount Omei, Szechwan, on August 3, 1921. It agrees in coloration with Pratt's Ichang specimens as figured by Guenther. The scale formula is: sc. 21; v. 176; a. 1; subc. 42+. The large smooth temporal is a very striking character and serves at once to separate *T. jerdonii* from the other Chinese species. The species has no particular relationship with *T. mucrosquamatus* and *T. elegans* as surmised by me[67] at a time when it was unknown to me except from description.

TRIMERESURUS GRAMINEUS (Shaw)

For synonymy see Herpetology of Japan, 1907, p. 480, to which add:

STANLEY, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 31 (Chekiang; Fukien; Hainan); vol. 46, 1915, p. xiii (Kuling Swatow), vol. 47, 1916, p. xiv (Hoihow; Foochow); vol. 48, 1917, p. xii.

Two rather young specimens (Nos. 64022–23) from Moh-Kan-Shan, Chekiang province) have been received from C. H. Barlow. They are in every way typical, green, with tail end more brownish, and a well-marked yellow lateral stripe.

[67] Herp. Japan, p. 468.

Order TESTUDINATA

Family PLATYSTERNIDAE

Genus PLATYSTERNON Gray

1831. *Platysternon* GRAY, Proc. Zool. Soc. London, 1831, p. 106 (monotype *P. megacephalum* GRAY).
1848. *Platysternum* AGASSIZ, Nomencl. Zool. Index Univ., 1848, p. 856 (emendation).

PLATYSTERNON MEGACEPHALUM Gray

1831. *Platysternon megacephalum* GRAY, Proc. Zool. Soc. London, 1831, p. 107 (type locality, China; type in Brit. Mus.; J. Reeves, collector); Ill. Indian Zool., vol. 1, 1834 (pl. 62); Cat. Shield Rept. Brit. Mus., vol. 1, March 8, 1856, p. 49 (China).—DUMÉRIL and BIBRON, Erpét. Gén., vol. 2, 1835, p. 344; Atlas, pl. 16, figs. 2–2*a* (China).
Emys megacephala TEMMINCK and SCHLEGEL, Fauna Japon., Rept., 1835, p. 49, (not of Holbrook).
Platysternum megacephalum GUENTHER, Rept. Brit. India, 1864, p. 43.—SWINHOE, Proc. Zool. Soc. London, 1870, p. 409 (Kwangtung and Kwangsi).—BOETTGER, Offenbach. Ver. Naturk., 24–25 Ber., 1885, p. 135 (South China); 26–28 Ber., 1888, (p. 107).—BOULENGER, Ann. Mag. Nat. Hist. (ser. 5), vol. 19, June, 1887, p. 461, pls. 16–17 (osteology) Cat. Chel. Brit. Mus., 1889, p. 46 (China; Siam; Pegu; Burma).—WERNER, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p. 359 (South China).—SIEBENROCK, Sitz. Ber. Akad. Wiss. Wien, Math. Nat. Kl., vol. 116, sect. 1, Dec. 1907, p. 1742 (Kwangsi and Kwangtung); Zool. Jahrb. Suppl., vol. 10, pt. 3, 1909, p. 450 (South China to Burma and Pegu).—STANLEY, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 24 (Fukien); vol. 49, 1918, p. xiv (Foochow, Fukien).
1870. *Platysternon peguense* GRAY, Suppl. Cat. Shield Rept. Brit. Mus., vol. 1, p. 70 (type locality, Pegu; types in Brit. Mus.; W. Theobald, collector).

The first specimen (No. 66454) of this interesting snapping turtle ever received by the National Museum, was collected for it at Foochow, Fukien by A. de C. Sowerby. It corroborates the occurrence of this species so far north, as first recorded by Mr. Stanley.

Family TESTUDINIDAE

OCADIA SINENSIS Gray

For synonymy see Herpetology of Japan, 1907, p. 489, to which add:
Ocadia sinensis SIEBENROCK, Zool. Jahrb. Suppl., vol. 10, pt. 3, 1909, p. 470.
Emys sinensis STANLEY, Journ. N. China Asiat. Soc., vol. 45, 1914, p. 23 (Shanghai; Hangchow; Soochow; Fukien).

A characteristic specimen (No. 65427), a young recently hatched, was collected at Foochow, Fukien, by Sowerby.

GEOCLEMYS REEVESII (Gray)

Herp. Japan, 1907, p. 497, pl. 30. Add to synonymy:

Emys reevesii Steindachner, Reise Novara, Zool., vol. 1, Rept., 1867, p. 5 (Shanghai).

Damonia reevesii Steindachner, in Wiss. Erg. Reise Szechenyi Ostasien, vol. 2, 1898, p. 505 (Pingleang-fu, Kansu).

Geoclemys reevesii Siebenrock, Sitz. Ber. Akad. Wiss. Wien, Math.-Nat. Kl., vol. 116, sect. 1, 1907, p. 1758 (Kwangsi and Kwangtung); Zool. Jahrb. Suppl., vol. 10, pt. 3, 1909, p. 477.—Stejneger, Science (n. s.), vol. 27, 1908, p. 748.—Barbour, Mem. Mus. Comp. Zoöl., vol. 40, no. 4, 1912, p. 135 (Ichang).—Nikolski, Fauna Rossij, Rept., vol. 1, 1915, p. 5 (Canton; Foochow; Shanghai; Chemulpo; Kioto).

Damonia reevesi Vogt, Sitz. Ber. Ges. Naturf. Freunde, Berlin, 1914, p. 96 (Canton).—Stanley, Journ. N. China Asiat. Soc., vol. 47, 1916, p. xiv (Lake Taihu, Kiangsu).—Gee, Journ. N. China Asiat. Soc., vol. 50, 1919, p. 184 (Soochow).

Geoclemys reevesii unicolor Siebenrock, Sitz. Ber. Akad. Wiss. Wien, Math.-Nat. Kl., vol. 116, sect. 1, 1907, p. 1759 (Kwangsi and Kwangtung); Zool. Jahrb. Suppl., vol. 10, pt. 3, 1909, p. 477.

Damonia reevesi, var. *unicolor* Stanley, Journ. N. China Asiat. Soc., vol. 47, 1916, p. xiv (Lake Taihu, Kiangsu).—Gee, Journ. N. China Asiat. Soc., vol. 50, 1919, p. 184 (Lake Taihu).

The National Museum, besides the specimens enumerated in the Herpetology of Japan (p. 500), had already 5 good specimens (Nos. 46491–95) collected by P. L. Jouy at Hongkong and one (No. 31721) supposed to be from Shanghai by E. Deschamps. In addition, Mr. Sowerby has sent a young just hatched (No. 65426) from Foochow, Fukien, and a fine series of nine half-grown and adults (Nos. 65417–25) from Shanghai. These show the usual variations, and one (No. 65419) represents the melanistic phase nearly always found together with the normal form, a question which I have treated more fully in my article in "Science" quoted above. This specimen is uniformly black above, but the plastron is more or less dark walnut brown, lightest on the pectoral laminae near the median seam.

CYCLEMYS TRIFASCIATA (Bell)

1825. *Sternothaerus trifasciatus* Bell, Zool. Journ., vol. 2, p. 305, pl. 14 [13] (type locality unknown; type in Bell's Mus.).

Cistuda trifasciata Gray, Syn. Rept., 1831, p. 19 (loc. ?); Ill. Indian Zool., vol. 2, 1834 (pl. 61).

Cuora trifasciata Gray, Cat. Shield Rept. Brit. Mus., vol. 1, March 8, 1856, p. 42 (China).—Guenther, Rept. Brit. India, 1864, p. 14 (China).

?*Pyxidemys trifasciata* Fitzinger, Sitz. Ber. Akad. Wiss. Wien, Math.-Nat. Kl., vol. 42, 1861, p. 411 (Shanghai).

Terrapene trifasciata Strauch, Mém. Acad. Sci. St. Pétersbourg, ser. 7, vol. 5, no. 7, 1862, p. 27 (East Indies).—Boettger, Offenbach. Ver. Naturk., 24–25 Ber., 1885, p. 133 (Shanghai); 26–28 Ber., 1888, (p. 104).

Cyclemys trifasciata BOULENGER, Cat. Chel. Brit. Mus., 1889, p. 133 (South China).—WERNER, Abh. Bayer. Akad. Wiss., II Kl., vol. 22, pt. 2, 1903, p. 359 (Shanghai.—SIEBENROCK, Sitz. Ber. Akad. Wiss. Wien, Math.-Nat. Kl., vol. 116, sect. 1, 1907, p. 1763 (Kwangtung or Kwangsi); Zool. Jahrb. Suppl., vol. 10, pt. 3, 1909, p. 502 (Kwantung and Kwangsi; Batu Island).—BRUNER, Blätt. Aquar. Terr. Kunde, vol. 19, 1908 (p. 746, fig. 6).

Emys trifasciata STRAUCH, Mém, Acad. Sci. St. Pétersbourg, ser. 7, vol. 38, no. 2, 1890, p. 65 (Canton).

Cyclemmys trifasciata VOGT, Sitz. Ber. Ges. Naturf. Freunde, Berlin, 1914, p. 96 (Canton).

Only one specimen (No. 36413) of this species has come to the National Museum. It was collected by P. L. Jouy, 1881, in "China." It is highly desirable to obtain more material of this interesting species with definite localities so that its precise geographical distribution may be ascertained. The locality Shanghai based on Fitzinger's statement that the *Novara* Expedition brought it from there is not beyond suspicion, as Steindachner does not mention this species in his detailed account of the reptiles of that expedition.

Family TRIONYCHIDAE

AMYDA SINENSIS (Wiegmann)

Amyda sinensis (WIEGMANN) Herp. Japan, 1907, p. 524.

The student of the Chinese (and Japanese) soft-shell turtles is confronted by an unusually complicated problem, which because of its peculiar circumstances may perhaps remain unsolved. In the rivers from Hongkong north to the Amur, and also in Formosa and Japan proper, there occurs one or more forms of the Genus *Amyda*, which by some writers have been treated as a single species while others have regarded them as a "formenkreiss" consisting of possibly as many as 5 differentiated subspecies to be treated nomenclatorially as binominals or trinominals according to the individual views. The difficulties are chiefly due to (1) lack of material; (2) great variability of these animals; (3) breaking down of the natural barriers.

Lack of material.—One can hardly expect to do justice to the problem without a complete series from each of the main drainage areas of China and the islands, to consist of well preserved suites showing both the different stages of growth, the sexual and the individual variation within the hatching stage, the adolescent stage and the fully adult. Needless to say, such material exists as yet nowhere. Few museums indeed can boast specimens from more than a few localities, and those mostly of indifferent preservation and uncomparable because of different age or sex.

Variability.—To illustrate this it is only necessary to recite the fact that Père Heude, who once attempted the study of these turtles, felt constrained to propose 8 specific names (each with a different generic name) for the form inhabiting the lower reaches of the Yangtsekiang.

Breaking down of the natural barriers.—Two factors are here of importance, human agency in carrying these valuable food animals from place to place in order to market them or transplant them; physical changes in the environment, some of which may be due directly to man's activity in building canals, thus opening up direct water communication between different river systems, or the rivers themselves changing their course. Thus the Hwangho in 1852 broke through in a northeasterly direction debouching into the Gulf of Chili instead of 4 degrees of latitude further south. We are informed that because these turtles are considered a delicacy and fetch higher prices in Japan, they are shipped in great quantities to the latter country and elsewhere, so that one can not be sure that the specimens obtained in a locality actually is a native of that place. The history of these animals goes back to the tertiary epoch, and we know now how different the drainage of those times may have been from that of the present time. While one might be tempted to approach the problem of these forms on the hypothesis that each of the great river systems, such as the Amur, the Hwangho, the Yangtsekiang and the West River might have favored the differentiation of its own peculiar form, experience from elsewhere shows that specific or even subspecific differences in these turtles may be older than the present river drainages. A glance at the map suggests that the great northern loop of the Hwangho, encircling Ordos and northern Shensi, may in part at least have belonged to an entirely different river system at some earlier period.

The Hwangho may therefore easily share two different forms of closely related turtles with other rivers, as does the Tennessee River, and the explanation may be similar.[68]

The material received by the National Museum, since the publication of the Herpetology of Japan, is not of sufficient quantity or quality to affect the preliminary views there expressed.

No specimens from the Amur river drainage representing *A. maackii* are in the museum, and none has been received since the publication of the Herpetology of Japan, which can be referred to *A. schlegelii.*

The specimens which have been added I am now listing under the name of *A. sinensis* with some doubt. Only one is supposed to be from near the type of locality (No. 46488) having apparently been

[68] See Stejneger, Proc. U. S. Nat. Mus., vol. 62, art. 6, Feb. 10, 1923, pp. 1–3.

acquired in 1883 at Hongkong by P. L. Jouy. It is in an indifferent state of preservation, and may have been purchased in the market. I am therefore unable to decide whether *A. sinensis*, from the West River drainage and *A. irrorata* from the Yangtsekiang drainage are identical or not.

Comparing the remainder of our Chinese mainland soft-shell turtles with the Japanese material at my command, as listed in the Herpetology of Japan, two conclusions force themselves upon me, namely, first, that the confidence I had in the table of measurements (p. 516) was to a great extent misplaced, owing partly to the scantiness of the material and partly to the selection of the length of the dermal carapace as the unit (100) for comparison. On the other hand, the additional material bears out the fact alluded to on page 517, that the plastron is shorter in the Japanese form. Reducing the length of the plastron to per cent of the width of the membranous shell, the Japanese specimens vary from 85 to 94, averaging about 90 per cent, while the continental and Formosan specimens vary from 92 to 101, averaging 97 per cent.

The overlapping is caused by two specimens (Nos. 39313–4) collected by Mr. Sowerby in the Hwangho near Honanfu, Honan, in which the plastron is as short as the longest of the Japanese, namely, 92 and 94 to 100 of body width. In other respects they also agree with Japanese specimens, but as they still fall within the range of the size of the plastron of the other continental specimens I prefer to name them *A. sinensis*.

Two other specimens (Nos. 39333–4) also male and female, were collected by Sowerby further north in the same river drainage, namely, respectively, 30 miles south and 12 miles east of Yenanfu, Shensi. They are considerably older than the Honan specimens and for that reason are not strictly comparable with them. They differ in several respects, notably in having a much greater interorbital width, but without corresponding specimens of the forms both to the north and to the south I hesitate to pronounce them different. The question of their relationship to *A. schlegelii* which according to Nikoloki is the form collected by Przhevalski in the Mongolian reaches of the Hwangho, is particularly interesting, but no solution of this vexed problem seems possible at the present time.

From Shanghai we have now one specimen (No. 46515) sent by D. C. Jansen, and two (Nos. 65415–6) by Mr. Sowerby, who also sent two females (Nos. 66455–6) from Hangchow, Chekiang. From Professor Ping a specimen (No. 66854) was recently received from Nanking. The above are all probably 3 to 4 years old, except the ones from Honan which are older.

A hatchling (No. 65428) collected by Sowerby at Foochow, Fukien. upon comparison with specimens from Japan of exactly same age

and size differs in having the carapace wider and the tubercles on the dorsal ridges much more pronounced. The dark pattern on the plastron in the Fukien specimen differs somewhat from that of the Japanese[69]; the line between the epiplastron is absent; instead of the heart-shaped spot on the median line between the xiphiplastra, there are two spots well separated one on each side of the median line, the two spots on the soft skin in front of the vent are unusually large, as are also the spots on the bridge filling the entire triangular space between the outer branches of the hyo and hypoplastra.

There are several more species of soft-shell turtles occurring in southern China. These as well as good series of the common species from all the great river systems would be very welcome additions to the national collection.

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[69] Herp. Japan, pl. 35.

INDEX

[The black-faced numbers indicate generic or specific heading.]

A — Page

Ablabes chinensis 64, 65
major 84
sinensis 64
Achalinus braconnieri 79
rufescens 79
spinalis 79
acutus, Agkistrodon 100
Ancistrodon 100
adenopleura, Rana 23
Aelurophryne **10**
mammata **10**
aequifasciata, Natrix 69, 71
Agkistrodon **94**
acutus **100**
blomhoffi 94, 95, 96, 97
brevicaudatus 97
halys **94**, 95
blomhoffi 95, 96
brevicaudus 95, 96, **97**, 98, 99
caucasicus 95
intermedius 95, **96**
himalayanus 94
intermedius 95, 96, 97, 98
strauchi 95, 96, **98**, 99
tibetanus 98
albofuscus, Sphecodes 90
Alligator 34
sinensis 34
Amblycephalus chinensis **93**
Amphiesma flavipunctatum 72
tigrinum 73
amurensis kukunoris, Rana 21
Rana 20, 21
Takydromus 58, 61
Amyda irrorata 106
maackii 105
schlegelii 105, 106
sinensis **104**, 106
Ancistrodon acutus 100
intermedius 96
strauchi 98
annularis, Natrix 66, 67, 68, 69, 70, 71, 72
Tropidonotus 68
annulatus, Elapoides 90
anomalus, Coluber 81
Anoplophallus 90
maculatus 90, 91
arborea immaculata, Hyla 11
japonica, Hyla 11
sinensis, Hyla 10
stepheni, Hyla 11
ussuriensis, Hyla 11
argus, Eremias 63
arvalis, Rana 20
asiatica, Rana 19, 20, 22
temporaria 19
asiaticus, Bufo bufo 6

Page

asperrima, Natrix 66
atra, Naja naja 93
aulicus, Coluber 90, 91
Lycodon 91

B

bachtyana, Rana 19
balcatus, Hyladactylus 15
bankorensis, Bufo 7
Batrachuperus **5**, 6
pinchonii **5**
sinensis 5, 6
Batrachyperus 5
Batrachypterus 5
bennettii, Enhydris 80
berezowskii, Calamaria 92
bistrigatus, Polypodontophis 65
blomhoffi, Agkistrodon 94, 95, 96, 97
halys 95, 96
brevicaudus, Agkistrodon 97
Halys 97
Bombina orientalis 6
Bombinator orientalis 6
boulengeri, Rana 26
bowringii, Hemidactylus 37
braccata, Oxydozyga 33
braconnieri, Achalinus 79
Ophielaps 79
bramineus, Typhlops 64
braminus, Typhlops 64
braueri, Rhacophorus 30, 31
brenchleyi, Eremias 63
brevicaudatus, Agkistrodon blomhoffi 97
brevicaudus, Agkistrodon blomhoffi 97
halys 95, 96, 97, 98, 99
brevipes, Pachytriton 4, 6
Triton 4
buccatus, Homalopsis 90
bufo asiaticus, Bufo 6
Bufo bufo asiaticus **6**
bankorensis 7
himalayanus 8
japonicus 6
mammatus 10
melanostictus 8, 10
nouettei 8
raddei 8, 9
raddei pleskei 8
przewalskii 8
viridis 9
vulgaris 6
Bungarus caeruleus multicinctus 94
candidus 94
multicinctus **94**
semifasciatus 94
burkilli, Rana 29
tigrina 29

C

Page
Cacopus systoma 17
caeruleus multicinctus, Bungarus 94
Calamaria berezowskii 92
quadrimaculata 91
septentrionalis **91**, 92
Callula 15
tornieri 17
Calohyla 15
candidus, Bungarus 94
Cantonophis 77
praefrontalis 77
carinatus, Coryphodon 87
caucasicus, Agkistrodon halys 95
caudivolvulus, Phrynocephalus 41, 42, 43, 44
chensinensis, Rana **20**, 21
chinensis, Ablabes 64, 65
Amblycephalus 93
Cynops 4
Enhydris **79**
Eumeces 46, **47**, 48, 51
Hyla **10**
Hypsirhina 79
Oxyglossa lima 33, 34
Rana 17
esculenta 17
Sibynophis 66
collaris **64**
Tropidonotus 68
chloris, Herpetodryas 85
cinereus, Simotes 89
Cistuda trifasciata 103
collaris chinensis, Sibynophis **64**
Polyodontophis 64, 65
Sibynophis 65
Coluber anomalus 81
aulicus 90, 91
conspicillatus 84
mandarinus 84
nigromarginatus 87
rufodorsatus 80
schrenckii 81
taeniurus 83
vaillanti 83
conjunctus, Halonectes 15
conspicillata, Elaphe 84
conspicillatus, Coluber 84
Coronella violacea 89
Coryphodon carinatus 87
dhumnades 87
cruenta, Rana 19
Cryptobranchus maximus 3
Cuora trifasciata 103
cyanocincta, Disteira **94**
Lioselasma 94
Cyclemys trifasciata **103**, 104
Cyclophis major 84
Cynops chinensis 4

D

Damonia reevesii 103
unicolor 103
Dasia smaragdina 93
davidiana, Sieboldia 3
dennysi, Polypedates 31
Rhacophorus **31**
Dermodactylus pinchonii 5
Page
dhumnades, Coryphodon 87
Zaocys **87**, **88**
Dinodon rufozonatum **89**
dione, Elaphe 81, 82, **83**
Diplopelma ornatum 11
pulchrum 11
Disteira cyanocincta **94**
dolleyanus, Holarchus 89
doriae, Liopeltis 85
dorsalis, Pseudoxenodon 75, 76
Tropidonotus 75
dussumieri, Eurostus 80
Hypsirhina 80

E

Elaphe conspicillata 84
dione 81, 82, **83**
mandarinus **84**
rufodorsata **80**
schrenckii **81**, 82
taeniurus 82, **83**
Elapoides annulatus 90
elegans, Eumeces **45**, 46, 51
Trimeresurus 101
emeljanovi, Rana **26**
Emys megacephala 102
reevesii 103
sinensis 102
trifasciata 104
Enhydris bennettii **80**
chinensis **79**
plumbea **80**
Eremias argus **63**
brenchleyi 63
multiocellata 63
planiceps 63
eremita, Microhyla **11**, 12
esculenta chinensis, Rana 17
Rana 18
Eumeces **44**, 45
chinensis 46, **47**, 48, 51
elegans **45**, 46, 51
latiscutatus 51
marginatus 51
pekinensis **49**
punctatus 45
quadrilineatus 46
rufescens 45
skiltonianus 46
tunganus **51**
xanthi 45, 46, 51, 52
Euprepis 45
Eurostus dussumieri 80

F

feae, Rana 25
fissipes, Microhyla **12**, 14, 15
flaviceps, Japalura **38**
flavipunctatum, Amphiesma 72
formosanus, Holarchus 89
frontalis, Phrynocephalus 42, 43, **44**

G

Gecko swinhoei 36
Gekko japonicus 35, 36, 37
subpalmatus **35**, 36
swinhonis 35, **36**, 37

Page

geminatus, Sibynophis 65
Geoclemys reevesii 103
unicolor 103
gracilis, Rana 28
grahami, Microhyla 13, 15
Phoxophrys 39, 41
gramineus, Trimeresurus 101
guentheri, Rana 24

H

habereri, Natrix 66, 68
tropodonotus 68
hainanensis, Simotes 89
Halonectes 15
conjunctus 15
halys, Agkistrodon 94, 95
Halys blomhoffi 97
halys blomhoffi, Agkistrodon 95, 96
brevicaudus, Agkistrodon 95, 96, 97, 98, 99
caucasicus, Agkistrodon 95, 96
intermedius, Agkistrodon 95, 96
handeli, Natrix 74
harti, Ophisaurus 63
Helioscopus 41
Hemidactylus bowringii 37
Herpetodryas chloris 85
heymonsi, Microhyla 12, 13
himalayanus, Agkistrodon 94
Bufo 8
Tropidonotus 75
Holarchus dolleyanus 89
formosanus 89
violaceus 89
Homalopsis buccatus 90
Hydrostentor pantherinus 29
Hyla arborea immaculata 11
japonica 11
sinensis 10
stepheni 11
ussuriensis 11
chinensis 10
palmata 30
stepheni 11
Hyladactyla 15
Hyladactylus 15
baleatus 15
Hylaedactylus 15
Hylorana malabarica 24
Hynobius keyserlingii 4
Hypsirhina chinensis 79
dussumieri 80
plumbea 80
sinensis 80

I

immaculata, Hyla arborea 11
indicum, Lygosoma 52
indicus, Sphenomorphus 52
intermedius, Agkistrodon 95, 96, 97, 98
halys 95, 96
Takydromus 57, 58, 59, 61, 62
irrorata, Amyda 106

J

Japalura flaviceps 38
splendida 38
swinhoii 38
yunnanensis 38

Page

japonica, Hyla arborea 11
Rana 19, 20, 22
japonicus, Bufo 6
Gekko 35, 36, 37
Megalobatrachus 3
jerdonii, Lachesis 101
Trimeresurus 101

K

Kaloula 15
pulchra 15, 17
rugifera 16
tornieri 17
verrucosa 17
keyserlingii, Hynobius 4
korros, Ptyas 86
Zamenis 86
kuhlii, Rana 26, 27
kukunoris, Rana amurensis 21

L

Lachesis jerdonii 101
Lamprosaurus 45
laterale, Leiolopisma 52
reevesii, Lygosoma 52
lateralis, Natrix 73, 74
latiscutatus, Eumeces 51
latouchii, Tapinophis 77
latrans, Rana 26
Leiolopisma laterale 52
Leptorhytaon 90
leucomystax megacephalus, Polypedates 30
Polypedates 30
Rhacophorus 30, 31
lima chinensis, Oxyglossa 33, 34
Oxyglossus 33
Oxygozyga 33
Rana 33
limnocharis, Rana 27
Liopeltis doriae 85
Liopeltis major 84, 85
Lioselasma cyanocincta 94
longicrus, Rana 22
ludovici, Ophisaurus 64
Lycodon 90
aulicus 91
rufozonatus 89
subcinctus 90, 91
Lygosaurus pellopleurus 54, 55
sowerbyi 53
Lygosoma indicum 52
laterale reevesii 52
reevesii 52

M

maackii, Amyda 105
macrophthalmus, Tropidonotus 75
Xenodon 75
macrops, Pseudoxenodon 74, 75, 76
Tropidonotus 74
maculatus, Anoplophallus 90, 91
Megalops 90, 91
Polypedates 30
unicolor, Polypedates 30
major, Ablabes 84
Cyclophis 84
Liopeltis 84, 85

Page

malabarica, Hylorana 24
mammata, Aelurophryne 10
mammatus, Bufo 10
mandarinus, Coluber 84
Elaphe 84
marginatus, Eumeces 51
martensi, Rana 20
martensii, Phrynoglossus 33
Masticophis 86
spinalis 86
maximus, Cryptobranchus 3
Megalobatrachus 3
megacephala, Emys 102
megacephalum, Platysternon 102
megacephalus, Polypedates 30
leucomystax 30
Megalobatrachus japonicus 3
maximus 3
Megalochilus 41
Megalophilus 41
Megalops maculatus 90, 91
melanostictus, Bufo 8, 10
meridionalis, Tachydromus 55, 56
Takydromus sexlineatus 55
Microdiscopus 33
sumatranus 33
Microhyla eremita 11, 12
fissipes 12, 14, 15
grahami 13, 15
heymonsi 12, 13
ornata 11
sowerbyi 14
Molge pyrrhogastra 4
mucrosquamatus, Trimeresurus 100, 101
multicinctus, Bungarus 94
caeruleus 94
multifasciatus, Simotes 89
multiocellata, Eremias 63

N

Naja naja atra 93
Natrix 67
aequifasciata 69, 71
annularis 66, 67, 68, 69, 70, 71, 72
asperrima 66
habereri 66, 68
handeli 74
lateralis 73, 74
muchalis 72, 73
percarinata 66, 67, 68, 70, 71, 72
piscator 66, 67, 68, 72
stolata 73
tigrina 73
lateralis 73
tigrinus 74
nigromaculata, Rana 17, 18
nigromarginatus, Coluber 87
Zaocys 87, 88
nouettei, Bufo 8
nuchalis, Natrix 72, 73
Trirhinopholis 77, 78, 79
Tropidonotus 72

O

Ocadia sinensis 102
omeimontis, Polypedates 31
Ophielaps braconnieri 79

Page

Ophisaurus 64
harti 64
ludovici 64
Ophites 90
orientalis, Bombina 6
Bombinator 6
Triton 3
pyrrhogaster 4
Triturus 3
ornata, Microhyla 11
ornatum, Diplopelma 11
oshimai, Zaocys 88
Oxydozyga 33
braccata 33
lima 33
Oxyglossa lima chinensis 33, 34
Oxyglossis 33
Oxyglossus 33
lima 33
Oxygozyga lima 33

P

Pachytriton 4
brevipes 4, 6
palmata, Hyla 30
pantherina, Rana tigrina 29
pantherinus, Hydrostentor 29
Pariocela 44
pavimentatus, Scincus 45
peguense, Platysternon 102
pekinensis, Eumeces 49
Pelida 15
pellioti, Zamenis 83
pellopleurus, Lygosaurus 54, 55
percarinata, Natrix 66, 67, 68, 70, 71, 72
percarinatus, Tropidonotus 71
Phoxophrys 39, 40
grahami 39, 41
tuberculata 39, 41
Phrynocephalus 41
caudivolvulus 41, 42, 43, 44
frontalis 42, 43, 44
potanini 42, 43
Phrynoglossus 33
martensii 33
phrynoides, Rana 25
Phrynosaurus 41
pictus, Plectropus 15
pinchonii, Batrachuperus 5
Dermodactylus 5
piscator, Natrix 66, 67, 68, 72
Tropidonotus 27
plancyi, Rana 18
planiceps, Eremias 63
Platysternon 102
megacephalum 102
peguense 102
Platysternum 102
megacephalum 102
Plectropus 15
pictus 15
Pleistodon 44
pleskei, Bufo raddei 8
Rana 10
Plestiodon 44
Plistodon 45

Page
plumbea, Enhydris 80
Hypsirhina 80
Polyodontophis bistrigatus 65
collaris 64, 65
subpunctatus 65
Polypedates 29
dennysi 31
leucomystax 30
megacephalus 30
maculatus 30
unicolor 30
megacephalus 30
omeimontis 31
potanini, Phrynocephalus 42, 43
praefrontalis, Cantonophis 77
przewalskii, Bufo raddei 8
Psammodynastes pulverulentus 93
Psammophis schokari 86
Pseudoxenodon 74
dorsalis 75, 76
macrops 74, 75, 76
sinensis 76
sinensis 75, 76
Ptyas korros 86
pulchra, Kaloula 15, 17
pulchrum, Diplopelma 11
pulverulentus, Psammodynastes 93
punctatus, Eumeces 45
pyrrhogastra, Molge 4
Pyxidemys trifasciata 103

Q

quadrilineatus, Eumeces 46
quadrimaculata, Calamaria 91

R

raddei, Bufo 8, 9
pleskei Bufo 8
przewalskii Bufo 8
Rana adenopleura 23
amurensis 20, 21
amurensis 21
kukunoris 21
arvalis 20
asiatica 19, 20, 22
bachtyana 19
boulengeri 26
burkilli 29
chensinensis 20, 21
chinensis 17
cruenta 19
emeljanovi 26
esculenta 18
chinensis 17
feae 25
gracilis 28
guentheri 24
japonica 19, 20, 22
kuhlii 26, 27
latrans 26
lima 33
limnocharis 27
longicrus 22
martensi 20
nigromaculata 17, 18
Rana phrynoides 25
plancyi 18
pleskei 10
ricketti 23
rugosa 24, 29
rugulosa 25, 28
spinosa 26
sylvatica 22
temporaria 19, 20
asiatica 19
tibetana 24, 25
tigerina 28
tigrina 29
burkilli 29
pantherina 29
vittigera 29
yunnanensis 25
reevesii, Damonia 103
Emys 103
Geoclemys 103
Lygosoma 52
laterale 52
unicolor, Damonia 103
Geoclemys 103
Rhacophorus 29
braueri 30, 31
dennysi 31
leucomystax 30, 31
ricketti, Rana 23
rufescens, Achalinus 79
Eumeces 45
Scincus 45
rufodorsata, Elaphe 80
rufodorsatus, Coluber 80
rufozonatum, Dinodon 89
rufozonatus, Lycodon 89
rugifera, Kaloula 16
rugosa, Rana 24, 29
rugulosa, Rana 25, 28

S

Saccostoma 41
Salamandrella keyserlingii 4, 5
sinensis 5
sauteri, Takydromus 61
schlegelii, Amyda 105, 106
schokari, Psammophis 86
schrenckii, Coluber 81
Elaphe 81, 82
Scincus pavimentatus 45
rufescens 45
semifasciatus, Bungarus 94
Simotes 89
Tropidonotus 68
septentrionalis, Calamaria 91, 92
Takydromus 57, 58
sexlineatus meridionalis, Takydromus 55
Tachydromus 55
Takydromus 61
Sibynophis 65
chinensis 66
collaris 65
chinensis 64
geminatus 65
subpunctatus 65

Page

Sieboldia davidiana 3
sikkimensis, Tropidonotus 75
silvatica, Rana 22
Simotes cinereus 89
  hainanensis 89
  multifasciatus 89
  semifasciatus 89
  swinhoei 89
  violaceus 89
sinensis, Ablabes 64
  Alligator **34**
  Amyda **104**, 106
  Batrachuperus 5, 6
  Emys 102
  Hyla arborea 10
  Hypsirhina 80
  Ocadia **102**
  Pseudoxenodon 75, 76
  Salamandrella 5
skiltonianus, Eumeces 46
smaragdina, Dasia 93
smaragdinus, Takydromus 61
sowerbyi, Lygosaurus **53**
  Microhyla **14**
Sphecodes 90
  albofuscus 90
Sphenomorphus indicus **52**
spinalis, Achalinus 79
  Masticophis 86
  Zamenis 86
spinosa, Rana **21**
splendida, Japalura **38**
stepheni, Hyla **11**
  arborea 11
Sternothaerus trifasciatus 103
stolata, Natrix **73**
stolatus, Tropidonotus 73
strauchi, Agkistrodon 95, 96, **98**, 99
  Ancistrodon 98
styani, Trirhinopholis **77**, 78
subcinctus, Lycodon **90**, 91
subpalmatus, Gekko **35**, 36
subpunctatus, Polyodontophis 65
  Sibynophis 65
sumatranus, Microdiscopus 33
swinhoei, Gecko 36
  Simotes 89
swinhoii, Japalura 38
swinhonis, Gekko 35, **36**, 37
  Simotes 89
  Tropidonotus 72
sylvatica, Rana 22
systoma, Cacopus 17

T

tachydromoides, Takydromus 61
Tachydromus amurensis 58, 61
  meridionalis 55, 56
  septentrionalis 57
  sexlineatus 55
taeniurus, Coluber 83
  Elaphe 82, **83**
Takydromus amurensis 58
  intermedius 57, 58, 59, 61, 62
  sauteri 61
  septentrionalis **57**, 58
Takydromus sexlineatus 61
  meridionalis **55**
  smaragdinus 61
  tachydromoides 61
  wolteri 61
Tapinophis **77**
  latouchii **77**
temporaria asiatica, Rana **19**
  Rana 19, **20**
terrapene trifasciata 103
Tetragonosoma 90
tibetana, Rana **24**, 25
tibetanus, Agkistrodon 98
tigerina, Rana 28
tigrina burkilli, Rana 29
  lateralis, Natrix **73**
  Natrix 73
  pantherina, Rana 29
  Rana 29
tigrinum, Amphiesma 73
tigrinus, Natrix 74
  Tropidonotus 73
tornieri, Callula 17
  Kaloula **17**
trifasciata, Cistuda 103
  Cuora 103
  Cyclemys **103**, 104
  Emys 104
  Pyxidemys 103
  Terrapene 103
trifasciatus, Sternothaerus 103
Trimeresurus elegans 101
  gramineus **101**
  jerdonii **101**
  mucrosquamatus **100**, 101
  xanthomelas 101
Trirhinopholis **77**
  nuchalis 77, 78, 79
  styani **77**, 78
Triton brevipes 4
  orientalis **3**, 4
  pyrrhogaster orientalis 4
Triturus 3
  orientalis **3**
Tropidonotus annularis 68
  chinensis 68
  dorsalis 75
  habereri 68
  himalayanus 75
  macrophthalmus 75
  macrops 74
  nuchalis 72
  percarinatus 71
  piscator 72
  semifasciatus 68
  sikkimensis 75
  stolatus 73
  swinhonis 72
  tigrinus 73
    lateralis 73
tuberculata, Phoxophrys 39, **41**
tunganus, Eumeces **51**
Typhlops bramineus 64
  braminus **64**
Tytleria **90**

U — Page

unicolor, Damonia reevesi ---- 103
Geoclemys reevesii ---- 103
Polypedates maculatus ---- 30
ussuriensis, Hyla arborea ---- 11

V

vaillanti, Coluber ---- 83
verrucosa, Kaloula ---- 17
violacea, Coronella ---- 89
violaceus, Holarchus ---- 89
Simotes ---- 89
viridis, Bufo ---- 9
vittigera, Rana ---- 29
vulgaris, Bufo ---- 6

W

wolteri, Takydromus ---- 61

X — Page

xanthi, Eumeces ---- 45, 46, 51, 52
xanthomelas, Trimeresurus ---- 101
Xenodon macrophthalmus ---- 75

Y

yunnanensis, Japalura ---- 38
Rana ---- 25

Z

Zamenis korros ---- 86
pellioti ---- 83
spinalis ---- 86
Zaocys dhumnades ---- 87, 88
nigromarginatus ---- 87, 88
oshimai ---- 88

ON THE OCCURRENCE OF REMAINS OF FOSSIL PORPOISES OF THE GENUS EURHINODELPHIS IN NORTH AMERICA

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Tertiary porpoises with very long beaks, whose distal extremities are edentulous, have been known to science since 1867. Prof. E. D. Cope described a porpoise of this kind from the Miocene of Charles County, Maryland, under the name of *Rhabdosteus latiradix.*[1]

On December 17, 1867, Viscount DuBus[2] read a paper before the Royal Academy of Sciences of Belgium in which similar porpoises from the Black Crag formation of the Antwerp basin were described and named *Eurhinodelphis.* The skulls of the European forms were subsequently more or less fully described by Van Beneden, Gervais, and others. Finally, in 1901, 1902, and 1905, these forms were studied more thoroughly by Professor Abel,[3] and his monographs were accompanied by satisfactory illustrations. In the spring of 1907 F. W. True discovered a nearly complete skull of one of these long-beaked dolphins in the Miocene clay at Chesapeake Beach, Maryland, and subsequently William Palmer collected three imperfectly preserved skulls in the Calvert Cliffs, at points a few miles below Chesapeake Beach. No vertebrae were found associated with any of the skulls mentioned above. Hence the discovery of a fine skull and lower jaws in association with 16 vertebrae, 10 ribs, a humerus, scapula, and sternum by Norman H. Boss in August, 1918, has supplied some much-needed information regarding the skeleton. The acquisition of this material confirms the occurrence of the genus *Eurhinodelphis* in North American Miocene formations.

[1] Cope, E. D., Proc. Acad. Nat. Sci. Philadelphia [vol. 19], pp. 132, 145, Mar. 10, 1868, and Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 6, p. 91, 1868; True, F. W., Remarks on the fossil cetacean Rhabdosteus latiradix Cope, Proc. Acad. Nat. Sci. Philadelphia, pp. 24–29, text figs. 1–3, pl. 6, Apr. 22, 1908.

[2] DuBus, B., Sur quelques Mammiféres du Crag d'Anvers, Bull. Acad. Roy. Sci. Belgique, ser. 2, vol. 24, p. 569, 1867 (1868).

[3] Abel, O., Les dauphins longirostres du Boldérien (Miocène supérieur) des environs d'Anvers, Mem. Mus. roy. d'hist. nat. de Belgique, Bruxelles, pt. 1, vol. 1, pp. 1–95, pls. 1–10, text figs. 1–17, 1901; pt. 2, idem, vol. 2, pp. 101–188, pls. 11–18, text figs. 18–20, 1902; Les Odontocètes du Boldérien (Miocène supérieur) d'Anvers, idem, vol. 3, pp. 1–155, text figs. 1–27, 1905.

No. 2563.—Proceedings U. S. National Museum, Vol. 66, Art. 26.

Besides these skulls, several mandibles and numerous vertebrae, ribs, and limb bones, which are referable with little doubt to this genus have been obtained at this and other points in Maryland and Virginia. As Professor Abel's[4] promised description of the vertebrae, and other parts of the skeleton of the European species of the genus *Eurhinodelphis* has not yet appeared, a full comparison of these parts is not possible at present, but from such figures and records as have been published it is evident that a few of the American forms can be safely referred to the genus *Eurhinodelphis*, including not only those obtained from the Calvert cliffs, but also some of the vertebrae and other parts of skeletons described during the last half of the nineteenth century by Leidy, Cope, and other American writers. From the vertebrae at present available for study, two courses present themselves for the treatment of the material. One can follow Abel and state that there is a wide range of individual variation in corresponding vertebrae or adopt the view of Leidy and Cope that each type represents a different species.

The types of the American species already described by Cope and Leidy, under the names of *Priscodelphinus*, *Ixacanthus*, *Delphinapterus*, *Tretosphys*, and *Belosphys*, the majority of which are in the Academy of Natural Sciences of Philadelphia, necessarily demand attention. Since these latter consist almost exclusively of vertebrae, the question of generic and specific allocation is still an extremely difficult one. Many years ago Du Bus[5] attempted to meet this difficulty by assigning certain European forms to the American genus *Priscodelphinus*, but his material consisted entirely of skulls, while the various American species were described exclusively from vertebrae. This association did not, therefore, remove the difficulty but rather increased it. It is, of course, probable that the same species frequented both the European and the American shores of the Miocene ocean, but this can not be taken for granted, for it is known that certain existing species of porpoises are peculiar to European waters and others to American waters. Until further material is obtained at the type locality for *Priscodelphinus harlini*[6] some uncertainty will exist as to the proper allocation of this genus. An imperfect posterior dorsal vertebra represents all that is definitely known concerning the type species of this genus. Leidy reports that

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[4] Abel, O., Presentation, avec explications justificatives, d'une reconstruction de l'Eurhinodelphis, Dauphin longirostre du Boldérien des environs d'Anvers, Bulletin Société de Belge de Géologie, Paleont., et d'Hydrol, Bruxelles, vol. 20, Proces Verbal, pp. 163–166, 1906; Cetaceenstudien. I. Mitteilung: Das Skelett von Eurhinodelphis Cocheteuxi aus dem Obermiozän von Antwerpen, Sitzungsber. K. Akad. Wiss. mathem.-naturw. Kl., Wien, vol. 118, pt. 1, pp. 241–253, pl., March, 1909.

[5] Du Bus, B., Mammiféres nouveaux du Crag d'Anvers, Bull. Acad. Roy. Soc. Belgique, Bruxelles, ser. 2, vol. 34, p. 492, 1872.

[6] Leidy, J., Proc. Acad. Nat. Sci. Philadelphia, vol. 5, pp. 326–327, 1851 [figured by Harlan, R., Journ. Acad. Nat. Sci. Philadelphia, ser. 1, vol.4, p. 232, pl. 14, fig. 1, 1824.]

this vertebra was discovered in the green sand at Mullica Hill, New Jersey. Other vertebrae from Shiloh, New Jersey, have been assigned to this species.

According to the practice of Cope and others whereby generic and specific names were given to very fragmentary and incomplete remains of fossil cetaceans, the opportunities for setting up new genera and species for variations in structural modifications of vertebrae were practically unlimited. Since many of the genera and species erected by Cope and Leidy were based upon parts other than skulls, it has been very difficult to correlate or allocate the material, save in a few instances. The collection which forms the basis for this study comprises a number of porpoises with skulls and associated vertebrae. In studying this material it became evident that a number of well known genera of fossil cetaceans were present in the Chesapeake embayment during the Miocene epoch, some of which have not been reported previously. A preliminary study of this material in conjunction with the types of the previously described porpoises in the Academy of Natural Sciences of Philadelphia has convinced the writer that many of the Cope and Leidy types can not be allocated until associated skeletons of all the fossil cetaceans for which skulls are known are found.

Since Cope was practically the sole investigator of fossil pelagic mammals in North America at the time of his death, it was unfortunate that no one came forward to carry on this work. Hence interest in the problems involved lapsed. It was not until the Maryland Geological Survey began preparation of a series of reports to illustrate the natural resources of that State that any further interest was shown in the pelagic mammals of the Chesapeake embayment. When this series of reports was planned it was found advisable to secure the services of a number of specialists, and the pelagic mammals were allotted to Prof. E. C. Case. In the section of the report which deals with the Miocene, Case[7] described a fragmentary skull and associated mandibles as *Priscodelphinus* (?) *crassangulum*. A few years later, True[8] concluded that this form belonged in the genus *Schizodelphis*. In 1912[9] True published a detailed account of the skull and associated skeleton of *Delphinodon dividum*. This was the first account of a fairly complete fossil cetacean skeleton obtained from the Calvert formation. Following this publication, renewed interest was taken in the Calvert Miocene, and

[7] Case, E. C., Miocene Text, Maryland Geol. Surv., Baltimore, pp. 12–13, pl. 11, 1904.

[8] True, F. W. Smithson. Misc. Coll. (Quart. Is.). vol. 50, pt. 4, Publ. 1782, pp. 449–460, pls. 69–70, 1908.

[9] True, F. W., Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 15, pp. 165–194, pls. 17–26, 1912.

as a result William Palmer and Norman H. Boss, devoted a considerable portion of their personal time to the exploration of the Calvert exposures on the western shore of the Chesapeake Bay. Mr. Palmer was fortunate enough to collect a number of very interesting skulls. To Mr. Boss should be given credit not only for the discovery of some very valuable specimens, but also for the diligence and skill he has shown in the preparation of the specimens for study and exhibition.

Recent observations have shown that a number of the genera and species erected by Cope are not distinct types and that those forms which occur in the Calvert Miocene do not necessarily belong to different genera from those which are found in some of the Upper Miocene deposits of Europe. While several investigators have adduced much evidence to show that most of those cetaceans which inhabit oceans south of the Equator never enter the waters north of it, no one as yet has been able to satisfactorily explain why certain forms that frequent the European side of the Atlantic Ocean might not also be found on the North American coast as well. On this subject much remains as yet to be investigated, but the occurrence of *Eurhinodelphis*, *Schizodelphis*, *Squalodon*, etc., in the Calvert formation indicates that the same genera and possibly the same species frequented both sides of the Atlantic Ocean. It is possible that actual comparison and acquisition of more complete specimens, especially from deposits in northern Germany and Denmark, may supply some much needed information.

As the distribution of the Cetacea appears to be dependent upon the presence of an adequate food supply and as the organisms which form their food are dependent either directly or indirectly upon temperature, it is evident that those cetaceans which feed upon tropical or subtropical organisms would not be present in waters where temperate or arctic conditions prevailed. Hence in making comparisons between faunas and in attempting to correlate deposits in which pelagic mammals occur some allowance must be made for possible differences in climatic conditions. According to Dr. W. H. Dall [10] the Chesapeake series should be compared with the Miocene of north Germany, Belgium, and Denmark rather than with the more tropical Miocene of southern Europe. The temperature of the Chesapeake embayment, however, was considered to have been warmer than at present. The fauna represented is indicative of a temperate climate, thus differing from the boreal and subtropical faunas now present on the Atlantic coast.

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[10] Dall, W. H., Miocene Text, Maryland Geological Survey, Baltimore, pp. cxlix, cl. 1904.

The sedimentary record of the Calvert formation has been discussed by Shattuck [11] in an article entitled "The Geology of Calvert County," from which the following is quoted:

> The close of the Nanjemoy epoch was marked by an elevation of the region which brought the Eocene deposits above the ocean and exposed them to a prolonged attack of erosion. After the region had suffered extensively from the work of waves and rivers, it was again submerged beneath the ocean and the material composing the Calvert formation were deposited. As the Miocene sea advanced little by little on the sinking surface of the mainland, the waves caught up and reworked the clays and greensands of the various Eocene beds. The more obdurate fossils of the Eocene survived in a great measure the erosive work along the old Miocene shore and were carried out and deposited in deeper water. They may now be seen reworked in the basal member of the Calvert formation. The old shore line of the Miocene sea which was formed during the Calvert epoch of sedimentation has nowhere been preserved in Maryland, but the materials which composed the Calvert formation in this county were deposited in seas of moderate depth in which an abundance of life was present, as is shown by remains of diatoms and the extensive beds of fossil mollusks. The remains of whales and other cetaceans show that these vertebrates abounded in the ocean, and the discovery of a bone belonging to a gannet indicates that birds existed along the near-by shores. This particular form doubtless sought its food in the sea as the modern fishing gannets do at the present time.
>
> The Calvert epoch was brought to a close by the elevation of the region once more above the level of the ocean. A period of erosion followed which was probably of short duration and closed with the depression of the region again beneath the sea. Then followed the deposition of the Choptank and St. Mary's formations, in which conditions similar to those just described for the Calvert were repeated.

In spite of the process of erosion that must have been going on for a considerable period, remarkable exposures of the Calvert formation exist to-day along the western shore of the Chesapeake Bay. These cliffs, which extend along the western shore of the Chesapeake Bay from Chesapeake Beach southward to the mouth of the Patuxent River, a distance of about 35 miles, consist mainly of clays belonging to the division of the Maryland Miocene known as the Calvert formation. This area has been very carefully examined and described by the Maryland Geological Survey which has published a full account of the characteristics of the several superimposed strata or zones and of the molluscs contained in each.

It is a comparatively easy matter, therefore, to locate quite exactly the relative position of the various cetacean bones found in the cliffs. The Calvert cliffs have long yielded specimens of different species of toothed and whalebone whales, the former belonging to several different families and genera.

Near the base of zone 10 and in zone 4 oysters are present in large numbers. From this it would appear that a barrier beach had been

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[11] Shattuck, G. B., Calvert County, Maryland Geological Survey, Baltimore, pp. 106–107, 1907.

formed during each of these sedimentation intervals which shut off a portion of the sea bed, and in consequence brackish water conditions prevailed. Aquatic vegetation would thus gain a foothold and afford favorable environmental conditions for sirenians. The occurrence of crocodiles (*Thecachampsa?*) and the soft-shelled turtle (*Trionyx*) would also suggest that extensive lagoons were present in the Chesapeake embayment. Only a few scattered bones of sirenians have been found during the past 15 years, and this in turn suggests that these mammals were far from being plentiful. In time the barrier bars would advance landward and the lagoons would be gradually filled up with sediments. Complete skeletons of the smaller dolphins have been found above and below the zones which contain shells of oysters. This shows that the ocean tides had free access to these areas during such periods of sedimentation, and that the bluish clay in which they were embedded was laid down in quiet water some distance from land. The presence of certain river dolphin types related to *Inia* and *Platanista* tend to confirm the existence of a vast estuary in the present Chesapeake embayment. Almost all of the specimens of the larger cetaceans show either the action of surf waves or the presence of strong currents; the parts of the skeletons are widely scattered and associated vertebrae are of rare occurrence.

After a careful detailed study of the skulls of *Eurhinodelphis* in the National Museum, I am unable to satisfy myself that any one of them is identical specifically with any of the European species, though it is not unlikely that such identity may be established later.

Although there are a few more alveoli in the maxillae, these skulls show a closer agreement with *Eurhinodelphis longirostris*, the smallest species known from the Antwerp Basin, than with any of the others. The shape and relations of the anterior extremities of the palatines, the depth and proportions of the braincase, the width of the raised surface between the longitudinal furrows on the edentulous portion of the rostrum, and the direction of the basicranial axis are very similar. The differences pointed out in the descriptions of these specimens seem to have sufficient weight to justify the application of another specific name to the Calvert Miocene porpoise.

Professor Abel's description [12] of the family Eurhinodelphidae and its single genus *Eurhinodelphis* is as follows:

Family EURHINODELPHIDAE

Rostrum excessively elongated, occupying in one case (*Eurhinodelphis longirostris*) nine-elevenths of the length of the skull; bones of the rostrum very delicate; premaxilla strongly attenuated, form-

[12] Abel, O., Mem. Mus. roy. d'hist. nat. de Belgique, Bruxelles, vol. 3, pp. 117–119, 1905.

ing by itself, in *Eurhinodelphis longirostris*, much more than half of the rostrum; in *Eurhinodelphis cocheteuxi* it is, on the other hand, shorter than the rostral portion of the maxilla. Skull resembling that of the Ziphioids, either slightly convex (*Eurhinodelphis cocheteuxi*, *E. longirostris*) or with a transverse crest (*Eurhinodelphis cristatus*).

Maxilla and mandible, alone, bear teeth; maxilla with 37 to 60 conical teeth, single rooted in each maxilla; premaxilla edentulous, with a rudimentary alveolar gutter, with sharp borders, which extends to the anterior extremity of the rostrum. It is not certain that the lower jaw extends the whole length of the rostrum; perhaps it was shorter (as in *Ichthyosaurus longirostris*); in any case, the symphysis of the lower jaw is very long, and the mandible is furnished with conical teeth, very close together, and single rooted.

Lachrymal free, separated from the jugal by a suture; but with age sometimes ankylosed with it. Olfactory foramina are large. Supraorbital arch convex. Maxillae, above the orbits, especially in *Eurhinodelphis cristatus*, very thick (more in the male than in the female ?). Mesethmoid ossified for a small portion of its length, as in the Delphinoids; vomerine canal broad and closed above by the closely approximated premaxillae. Nasals very small, very variable in form, generally oval. Frontals usually contracted at the vertex, forming a narrow band, but sometimes entirely covered by the supraoccipital, which projects forwards strongly, and the nasals which are deeply embedded posteriorly; parietals always covered on the vertex of the skull.

The form of the different bones of the skull, especially the squamosal, varies greatly in different individuals.

All the cervical vertebrae are free. The atlas with the surfaces for articulation with the occipital condyles sometimes extended into wings on the external borders and having two superimposed transverse processes. Axis with a strong odontoid process and, on each side, a very strong imperforate transverse process. Centra of the succeeding cervical vertebrae, either thin, or very thick (*Eurhinodelphis longirostris*, *Priscodelphinus grandaevus*).

Thoracic vertebrae 10 or 11; the 8 anterior ones bearing bicipital ribs; the last 2 or 3 bearing single-headed ribs. At the eighth dorsal vertebra the rib articulates by the tuberculum to the diapophysis, and by the capitulum to the parapophysis; at the ninth dorsal vertebra the neck of the rib is joined with the parapophysis and the diapophysis becomes rudimentary, or forms, in descending toward the extremity of the rib, a transverse foramen with the neck; the rib articulates with the tuberculum on the neck of the separated rib. The tenth dorsal vertebra bears a very strong transverse process (the neck of the tenth rib, which is joined with the vertebra), and the

tenth rib articulates with it there. The thoracic vertebrae are, therefore, formed like those of the Physeteroids and the Ziphioids.

Transverse processes of the lumbar vertebrae remarkably short, slender, and narrow (*Ixacanthus spinosus*, *Eurhinodelphis cristatus*), or long and broad (*Eurhinodelphis cocheteuxi*, *E. longirostris*). Number of lumbar vertebrae probably 11, and of caudal vertebrae 19.

Number of vertebrae: Cervicals, 7; dorsals, 10 or 11; lumbars, 11; caudals, 19 = 47 or 48. Scapula very large, broad, and triangular, and similar to that of the Delphinoids. Prescapular fossa relatively broad, but the form of the scapula is variable. Humerus similar to that of *Physeter*, with the deltoid crest more or less developed; form of the articular head very variable; head of humerus ordinarily oval, extended over upon the external border of the bone. Radius and ulna large, strong, about as long as the humerus. Olecranon very large, and strongly notched below. Of the carpal bones the following are known: Radial, intermedium, and cubital which are ankylosed (old individual). The phalanges are present. The largest specimens of the largest species (*Eurhinodelphis cocheteuxi*) may have attained a length of 4 or 5 meters.

INDIVIDUAL 1

EURHINODELPHIS BOSSI, new species

Type.—Cat. No. 8842, Section of Vertebrate Paleontology, United States National Museum. This specimen consists of a complete skull with the exception of the ear bones, both lower jaws, sixteen vertebrae, ten ribs, an imperfect scapula, a humerus, and part of the sternum.

Type locality.—The occurrence is as follows: Near latitude 38° 40′ north, and longitude 76° 40′ west, about 2 miles south of Chesapeake Beach, on the western shore of Chesapeake Bay, Calvert County, Maryland. Shown on Patuxent Quadrangle or Patuxent Folio, No. 152, United States Geological Survey.

Horizon.—The specimen was discovered and excavated by Norman H. Boss in August, 1918. It was dug from the cliff above the oyster shell band. The specimen, apparently, was embedded in Shattuck's zone No. 5 of the Calvert Miocene formation of Maryland.

SKULL

Dorsal view.—Although the outlines and relations of the bones forming the dorsal surface of the skull (pl. 1) at first glance are strongly suggestive of *Schizodelphis*, there appear to be some well-marked differences. In the *Schizodelphis* skull the exposed portions of the frontals on the vertex are considerably larger than the paired nasals, and the teeth are swollen near the base of the crown and rather robust. Conversely, in the *Eurhinodelphis* skull the paired

nasals are nearly as large as the exposed portions of the frontals on the vertex, and the enamel-covered crowns of the teeth are anteroposteriorly compressed and rather slender.

This form is best characterized by the exceedingly long attenuate rostrum which comprises four-fifths of the total length of the skull. According to Abel [13] the premaxillae by themselves form more than half of the rostrum of an *Eurhinodelphis* skull. No trace of a suture between the maxilla and the premaxilla in a position corresponding to that shown by Abel could be made out on any of the specimens from the Calvert formation. A shallow groove which probably conveyed some nerve or blood vessel is present in the same relative position on the lateral face of the maxilla. Anterior to the maxillary notches the premaxillae are thick and convex; they decrease in breadth and in height toward the terminal portion of the rostrum. The inner margins become closely appressed to one another at a point 100 mm. in front of the maxillary notches and continue in contact to the extremity of the rostrum. The raised convex portions of the premaxillae do not parallel one another throughout the entire length of the rostrum, but spread apart rather abruptly in front of the maxillary notches. In this region they form the outer margin of the concave and flattened internal portions of the premaxillae, and in consequence of their tapering these elevated convex borders disappear in front of the nasals. The premaxillae commence to expand horizontally in front of the nasal bones and attain their maximum breadth at the level of the anterior margins of the nasal apertures. In front of the nares there is an oval concavity on each premaxilla. The posterior end of each premaxilla is abruptly narrowed along the external margin of the nasal. The premaxillary foramina are moderately large and situated posterior the maxillary ones. Each of these foramina open into two grooves. One of these is broad and deep and extends transversely across the premaxilla to its internal margin; the other, a longitudinal groove, which is continued backward to a point in front of the nasal, lies between the concave internal and the convex external portions of the premaxilla. Anterior to the transverse groove the internal surface of the premaxilla is somewhat flattened; this area narrows rapidly and finally disappears under the raised convex outer strip.

The premaxillae approximate each other so closely anterior to the maxillary notches that the mesorostral gutter is completely roofed over. Distally, the floor of the mesorostral gutter is formed entirely by the premaxillae which meet mesially and ventrally in a linear suture at a point slightly more than half way to the tip of

[13] Abel, O., Les dauphins longirostres du Boldérien (Miocène supérieur) des environs d'Anvers. Mem. Mus. roy. d'hist. nat. de Belgique, vol. 1, p. 65, 1901; vol. 3, p. 117, 1905.

the rostrum; proximally the vomer and the premaxillae contribute to its formation. Skulls of those cetaceans which possess an elongated beak have experienced various modifications in the relations of their component parts, but nevertheless in all forms now known the vomer has been lengthened and so placed as to afford a maximum support for the rostral and cranial portions of the skull. The vomer increases in width posteriorly and takes part in the formation of the lateral walls of the mesorostral gutter. The contact between the vomer and either premaxilla is clearly discernible distally in skulls with damaged beaks although their surfaces are so smoothly mortised into one another proximally that their relations can only be determined by making cross sections of the rostrum. The posterior limit of this contact between the vomer and the premaxilla is near the anterior margin of the presphenoid. On the base of the skull the vomer extends backward upon the basisphenoid.

The mesethmoid does not rise to the level of the premaxillae. It sheathes the dorsal and lateral faces of the presphenoid and thus forms a partition between the nasal passages superiorly, fills in the frontal fontanelle, and provides support for the nasals, and incidentally for the vertex of the skull. No trace of a pair of passages opening between the ectethmoids and the mesethmoid, and leading into the brain case could be found in any of the skulls examined. In skulls of *Diochotichus*, *Ceterhinops*, and *Squalodon* the mesethmoid incompletely fills the frontal fontanelle, and as a result a pair of relatively large foramina are formed, through which the olfactory nerves reached the respiratory passages. Abel[14] states that these foramina are present in a skull of *Eurhinodelphis longirostris*.

A slit-like anterior border for the nasal aperture is formed by the close approximation of the internal margins of the premaxillae. Because of this horizontal expansion of the premaxillae, most of the anterior end of the presphenoid as well as the nasal passages are hidden from view. The presphenoid is a porous bone which forms a plug across the proximal end of the mesorostral gutter, but does not rise to the level of the premaxillae above.

The dorsal surface of the skull is constituted almost entirely by the maxillae and premaxillae; the nasals and frontals form the vertex of the skull. The maxillary notches are shallow and rather broad. From a dorsal view, the maxillae are seen to increase in width from the tip of the rostrum posteriorly. When they reach the maxillary notches they push back over the supraorbital processes of the frontals and expand laterally to form the so-called frontal plates of the maxillae. They attain their greatest width opposite the large concavities on the premaxillae. These plates of the maxil-

[14] Abel, O., Les dauphins longirostres du Boldérien (Miocène supérieur) des environs d'Anvers. Mem. Mus. roy. d'hist. nat. de Belgique, Bruxelles, vol. 2, pp. 171, 172, 1902.

lae and the corresponding underlying lateral extensions of the frontals roof over the temporal fossae, but the former do not come in contact with the supraoccipital posteriorly because of the presence of a narrow intervening strip of the frontal. The outer margins of both maxillae are imperfect above the temporal fossae. The surface of the maxilla is somewhat depressed opposite to the nasals and slightly convex above the supraorbital plates of the frontals. The concavity is most evident above the temporal fossa. Two rather large foramina which connect with the infraorbital canal are present on each maxilla above the temporal fossa, and of these the anterior one is the larger. The internal margin of the maxilla, with the exception of that portion which overlaps the frontals on the vertex, is in contact with the premaxilla for practically its entire length. There are three additional foramina in each maxilla. The most posterior one of these is situated a little behind the notch, and from it there is a deep channel leading in a postero-external direction. The external border of the maxilla is convex in front of the maxillary notch, but this portion of the maxilla is relatively thin. Further forward the thin outer edge gradually disappears with the lateral compression of the rostrum and the maxilla appears to be deeper from a side view, but this is due to the outward and downward curvature of the dorsal surface. In correlation with this tapering, the maxilla decreases in breadth anteriorly and the sides become more nearly vertical. For a distance of about 250 mm. in front of the maxillary notch the inner border of the maxilla fits closely to the outer border of the premaxilla, but at this point a foramen appears between them, succeeded anteriorly by a broad and rather deep groove. This groove does not follow the inner margin of the maxilla, but extends directly forward, finally occupying the side of the maxilla and disappearing before reaching the end of the rostrum.

On comparing the dorsal view of the skull of *Eurhinodelphis cocheteuxi*[15] with this specimen, it was noted that the breadth of the anterior margin of that portion of the maxilla which overlies the supraorbital process of the frontal was proportionately less and that the maxilla sends forward a narrow projection which reduces the maxillary notch to a narrow groove. Although no anterior projection is present on the skull of *Eurhinodelphis longirostris*[16] this portion of the maxilla is even narrower than in *cocheteuxi*. According to the figures used by Abel, the lachrymal is not visible from a dorsal view of the skull in either *longirostris* or *cocheteuxi*. A small portion of the anterior end of the lachrymal projects forward in the left maxillary notch on the skull of

[14] Abel, O., Les dauphins longirostres du Boldérien (Miocène supérieur) des environs
[16] Abel, O., Idem, vol. 2, p. 11, 1902.

Eurhinodelphis cristatus.[17] In this specimen from the Calvert cliffs the maxilla does not completely sheath the anterior margin of the supraorbital process. The outer margin of the frontal plate of the maxilla is very irregular above the orbit, but on both maxillae there is a deep indenture which sets off a process comparable to that shown on the skull of *E. cocheteuxi.* This portion of the maxilla, however, does not project beyond the anterior edge of the supraorbital process to any appreciable extent, but it may show how a process like that present on the *E. cocheteuxi* skull was formed. In front of and below this process there is a small bone which is continuous ventrally with what was considered by Abel to be the lachrymal. This bone is fused with the jugal and is closely appressed to the maxilla. Differences in respect to the size and position of such bones are to be expected in different genera, but it may appear somewhat unusual that such modifications should be present in different species of the same genus. The anterior end of the jugal is not visible from a dorsal view.

The frontals are limited to a narrow strip on the vertex, being overspread by the premaxillae and maxillae laterally, and by the nasals anteriorly. Posteriorly they abut against the supraoccipital and intervene between the extremities of the maxillae and the latter. Anterolaterally and at a lower level than the vertex each frontal sends out a supraorbital process which forms a complete osseous roof for the orbit. No trace of a small bone described as the interparietal could be found on this skull.

The nasals are small semipyriform bones placed obliquely between the posterior extremities of the premaxillae, with their anterior portions in contact along their inner margins. In position they agree with those of *Eurhinodelphis cocheteuxi*, although in general outlines they are somewhat different. They do not overhang the nasal apertures.

Lateral view.—Aside from the relative small size of the braincase the skull (pl. 2) is characterized by a shallow temporal fossa which is roofed over for the most part by the maxilla and the lateral extension of the frontal, a wide orbit, and a long zygomatic process. The rostrum is exceedingly long and slender, depressed proximally, and compressed from side to side anteriorly. To compensate for strains arising from the length of the rostrum the posterior extremities of the maxillae are expanded horizontally. Additional strength is given to the rostrum by the almost complete ankylosis of the maxilla and premaxilla, as well as by the anterior extension of the vomer.

[17] Abel, O., Mem. Mus. roy. d'hist. nat. de Belgique, Bruxelles, vol. 2, p. 15, fig. 1, 1902.

A slight bowed effect is imparted to the rostrum by the curvature of the latero-ventral margin of the maxilla and by the combination of two other features, namely, the upward curvature of the anterior end and proximally by the gradual slope of the dorsal surface to the vertex of the skull. From a lateral view the maxilla appears to be deepest near the distal end of the proximal one-third of the rostrum, but this is due to the curvature of its outer and lower margin. At this point the maxilla is deeper than the premaxilla. Farther forward they are almost equal in depth. Inasmuch as some confusion may arise from differences in interpretation attention should again be directed to the absence in any of the skulls from the Calvert cliffs of any indication of a suture between the maxilla and premaxilla in the position shown by Abel. A shallow, ill-defined groove, however, is present on most of the skulls. If this groove really marked a suture, then the maxilla would taper and end in a sharp point while the premaxilla would increase in depth and finally comprise the extremity of the rostrum.

The orbit is moderately convex, the outer margin of the supraorbital process being thick and the superimposed plate of the maxilla thin and shelving. The preorbital portion of the supraorbital process is rounded, while the postorbital portion is compressed dorsoventrally. The lachrymal is closely appressed to the anterior face of the supraorbital process and is in contact with the maxilla. Below the maxillary notch the jugal fuses with the lachrymal and is attached to the maxilla. The jugal is a very slender bone and extends backward beneath the orbit to the anteroventral angle of the zygomatic process.

The zygomatic process of the squamosal is thickened dorsoventrally and is in contact with the postorbital portion of the supraorbital process. As a whole the zygoma is robust, curved, and rather long; the dorsal outline curves gradually forward and upward. The postglenoid portion of the zygoma curves backward and then forward. The greatest length of the right zygoma along the glenoid face is 98.5 mm. and the greatest depth anteriorly is 24 mm.

In this specimen the crest formed by the contact of the supraoccipital and frontal is the highest point in the dorsal profile. The dorsal outline of the skull slopes forward from the crest and in the region of the nares the declivity is more accentuated, but further forward the slope is more gradual. On each side of the vertex and in front of this crest the frontal plate of the maxilla is depressed, forming a well-marked concavity. The supraorbital process of the frontal and the superimposed maxilla rise above the premaxilla in front of the nares. The temporal fossa is longer than the orbit and its upper border is relatively straight, due in part to the lateral ex-

tension of a thin plate of the frontal to underlie the maxilla. In this fossa the parietal is suturally united inferiorly with the squamosal, anteriorly and superiorly with the frontal, and posteriorly with the supraoccipital. Hence the parietals are excluded from the dorsal surface of the skull. When viewed from the side, the condyles are seen to project beyond the plane of the exoccipitals. The basicranial axis is bent downward from the axis of the beak.

Posterior view.—This surface (pl. 4) attains its greatest breadth at the level of the exoccipitals. These exoccipitals are relatively large, coalesced with the supraoccipital above, and project outward and backward like wings. Their external margins are rounded, but are not produced so that they conceal the zygomatic processes from behind. Anteriorly they are in contact with the squamosal and inferiorly they unite with the basioccipital. The junction of the exoccipital with the basioccipital lies internal to the deep jugular incisure and crosses the falcate process of the latter. At the bottom of this incisure and near the posterior margin there is a small condylar foramen. The dorsal border of the exoccipital ascends about half way to the upper limit of the temporal fossa. Externally the upper portion of the exoccipital is produced backward, forming a crest which follows the curvature of the temporal fossa. This crest is continuous with the corresponding border of the supraoccipital and together they form the lambdoid crest. The dorsal contour of the supraoccipital is evenly rounded. Between the upper limits of the temporal fossae the supraoccipital is deeply concave, but becomes somewhat flattened above the foramen magnum. The greatest breadth of the supraoccipital is about equal to twice its depth above the condyles.

Because of crushing the occipital view of this cranium appears slightly unsymmetrical, and the distortion lies in the direction of a plane passing from the upper left-hand angle to the lower right-hand angle. This distortion has affected the contour of the foramen magnum to some extent, but originally it must have been suboval in outline. The occipital condyles are considerably broader near the apex than near the base, and slope outward and forward. The internal margins are concave and sharply defined, converging inferiorly. The external margins are convex and are set off from the exoccipitals by low necks. Below the condyles and internal to the exoccipitals are the descending plates of the basioccipital.

Ventral view.—In contrast to other porpoises with very long beaks there is reason to believe that the distal end of the rostrum of this form did not bear teeth. Of course, there is the possibility that a cartilaginous ligament might have lodged the teeth on this portion of the rostrum, for there is an uninterruped furrow extending from the anterior-most alveolus to the extremity. In that event the teeth

would readily become separated from the skull during decay or before the skull was buried by sediments. Sixteen teeth are in place on the right side of the rostrum and 33 teeth on the left. By counting the vacant alveoli and the teeth in place, it appears that originally 59 teeth were present on the right side and 60 on the left side. As by far the greater portion of the rostrum is constituted by the maxillae, they will be discussed first. Near the anterior end of the tooth row the external face of the maxilla is rounded, and in front of the vomer it is nearly vertical, but at a point 190 mm. in front of the maxillary notches the lower outer margin begins to twist upward. This portion of the maxilla becomes progressively thinner as it approaches the maxillary notches. Again it may be noted (pl. 1) that no indication of sutures to mark the presence of the premaxillae on the ventral surface of the rostrum can be traced in this or in any of the skulls mentioned in another part of this paper. Posteriorly the maxillae are separated for a short interval, permitting the keel of the vomer to appear between them. Behind this the maxillae are overlain by the palatines. The thin platelike process of the maxilla that extends backward to the optic canal is applied to the ventral face of the supraorbital process of the frontal. The ventral orifice of the infraorbital canal is bounded by the maxilla alone. In front of this orifice there is a shallow heart-shaped depression which extends over the palatine and the maxilla for a distance of 60 mm. in front of the maxillary notches.

There is nothing peculiar about the position of the palatines. They meet mesially and are closely appressed to the maxillae. Viewed from the side, the palatine extends forward beyond the maxillary notch and above the pterygoid projects backward to the anterior margin of the optic canal. Close to its posterior extremity, but above it, the palatine comes in contact with the orbitosphenoid.

The jugal is a long, slender bone, consisting of a short, triangular, dorso-ventrally expanded anterior portion which is closely joined to the maxilla and lachrymal, and a styliform posterior process. The posterior end of the latter is flattened and extremely thin, being loosely attached to the ventral face of the zygomatic process.

The lachrymal is closely appressed to the anterior face of the supraorbital process of the frontal and is sheathed dorsally by the maxilla, while internally it appears to be fused with the jugal. Inasmuch as no suture can be found it should be stated that these combined bones occupy the lower margin of the maxillary notch.

Some confirmation as to the true relations of the pterygoids with the surrounding bones appears to be found in certain living porpoises. By studying the relations of the various bones involved in this and other skulls hereinafter mentioned it was apparent that the type of structure present was essentially in agreement with that of

a young *Delphinapterus*. The two plates of the pterygoid are separated from each other by a narrow interval anteriorly, but posteriorly they are widely separated. Behind the middle the two plates of the pterygoid are divergent, the external plate coming in contact with the squamosal and parietal, and the internal plate overlapping the anterior margin of the basisphenoid behind and the palatine in front. Anteriorly, the internal plate becomes somewhat curved and contributes the lower outer surface for the nasal passage. This portion of the internal plate bends inward and then outward and is continuous anteriorly with the external plate of the pterygoid. On the outside of the pterygoid and in front of the nasal passage there is a lateral concavity. Below this concavity the lateral margin of the pterygoid flares out. The external plate of the pterygoid apparently contributes the horizontal backwardly projecting hamular process which represents a posterior extension of the palatal surface. The opening into the sinus between the two plates of the pterygoid lies internal and anterior to the falciform process of the squamosal. Although this sinus is exposed along the right nasal passage of this skull, it is because the horizontal hamular process of the pterygoid broke off at that level. The anterior margin of the external plate of the pterygoid is united by a S-shaped suture with the palatine. The external plate of the pterygoid articulates with the squamosal, parietal, frontal, and palatine. The posterior half of the external plate is arched over the alisphenoid, and excludes the latter from the temporal fossa and from the outer wall of the cranium. The upper and anterior portion of the internal plate of the pterygoid is applied to the ventral surface of the orbitosphenoid.

On the right side of the skull, the external plate of the pterygoid is imperfect. One is thus permitted to study the relations of the alisphenoid, internal plate of the pterygoid, and orbitosphenoid. Fortunately these bones are essentially perfect in this skull. The alisphenoid is broad, outwardly and upwardly curved, extending to and suturally united above with the squamosal and parietal. Further forward there is a small orbitosphenoid which projects laterally on the ventral surface of the supraorbital process. Both plates of the pterygoids are well preserved on the type skull, but on all the others they have been destroyed in the region of the sphenoidal fissure. By utilizing data obtained from all the specimens, it has been possible to work out most of the details in this region. The conditions observable in the region of the sphenoidal fissure appear to be essentially the same as in the skull of an adult *Delphinapterus*, although in the young of the latter the anterior foramina are not so well defined. As in *Delphinapterus*, the orbitosphenoid forms the lower portion of the anterior wall of the brain case. Between the alisphenoid and the orbitosphenoid there is a sphenoidal fissure,

varying in outline and in extent in the different skulls. The alisphenoid is overridden anteriorly by the internal plate of the pterygoid, thus closing the sphenoidal fissure laterally. The optic canal while confluent with the sphenoidal fissure, nevertheless has its course marked by a definite groove, and is bounded anteriorly by the descending portion of the orbitosphenoid. No trace of a posterior partition or taenia metoptica could be found in any of these skulls. As in *Delphinapterus* the foramen rotundum appears to be situated in the angle formed by the anterior margin of the alisphenoid where it comes in contact with the frontal. In some skulls of *Delphinapterus* there is a well-defined anteriorly directed canal leading from this angle for conveying the maxillary branch of the trigeminal nerve. This canal is distinct from a wider channel leading from the sphenoidal fissure, but terminates at the posterior margin of the broad trough for the optic nerve on the ventral face of the supraorbital process of the frontal. A similar canal or groove can be made out on one or two of these fossil skulls, but the interval between this canal and that leading from the spenoidal fissure is much reduced. When the pterygoid is in position the foramen rotundum as well as its canal and the sphenoidal fissure are hidden from view. Near the base of the alisphenoid and partially overlapped by the vaginal process of the pterygoid is the ectal orifice of the canal for the carotid artery. The mandibular branch of the trigeminal nerve issues through a cleft on the posterior margin of the alisphenoid at a point 9 mm. external to the carotid canal and on its outward course occupies a channel on the ventral face of this bone, finally emerging in the temporal fossa through the foramen ovale. The latter is situated between the falciform process of the squamosal and the parietal, immediately behind the posterior extremity of the pterygoid. In front of the carotid canal and the channel for the mandibular branch of the trigeminal nerve, the alisphenoid curves abruptly upward forming with internal plate of the pterygoid a large concavity. This concavity may be further divided into a semicircular internal portion and an elongate external portion. The posterior margin of the internal plate of the pterygoid extends obliquely across this concavity.

In this region the wall of the cranium consists of three layers of bone. These, from the inside outwards, are: First, the alisphenoid, which occupies the interval between the frontal, parietal, and basisphenoid; next, the pterygoid proper, that is, the internal plate which overspreads the sphenoidal fissure, overlaps the lateral margin of the basisphenoid, and contributes the lower outer wall of the nasal passage; and, lastly, the external reduplication of the pterygoid

which is in contact posteriorly with the squamosal, anteriorly with the palatine, and superiorly with the parietal and frontal.

By the backward extension of the alisphenoid (pl. 5) and its contact with the underlying process of the basioccipital, a recess is formed which completely excludes the periotic and tympanic from the inner wall of the cranium. Above the descending plate or falcate process of the basioccipital and near its posterior extremity two foramina appear within the recess thus formed. The anterior one of these pierces the bone and probably represents the compartment for the nerves in the *foramen lacerum posterius*. The posterior compartment would then be the passage for the vein in the same foramen. These two compartments are not distinct in the type skull and the intervening bar of bone apparently never formed. The condylar foramen is situated near the posterior margin of the deep incisure between the paroccipital process and the descending plate of the basioccipital. Two condylar foramina are present in each jugular incisure on one of the skulls.

In the type skull the line of union between the basioccipital and the basisphenoid can not be traced with certainty. The ventral surface is concave from side to side. The descending plates or falcate processes of the basioccipital are directed downward, backward, and outward, and anteriorly they become closely united with those portions of the internal plates of the pterygoids which overlap the basisphenoid.

No attempt was made to clean the matrix from the brain case of this skull and hence the position of the sutures between the bones in the basicranium can not be traced. In another skull (Individual 2), however, the anterior surface of the basisphenoid has not united with the presphenoid. The presphenoid is rodlike in the middle to conform with the deep groove of the vomer.

The vomer is horizontally expanded posteriorly, sheathing the basisphenoid and meeting the vaginal plates of the pterygoids along its lateral margins. In front of the basisphenoid and between the nasal passages the vomer becomes noticeably constricted, forming a trough in which the presphenoid rests. It forms the lower portion of the posterior and internal walls for each nasal passage, extending upward to meet the corresponding descending plate of the ectethmoid. Between the nasal passages the vomer presents a keel which anteriorly is interposed between the hamular processes of the pterygoids. In front of these processes the vomer is covered by the palatines and the maxillae, but at a point 92 mm. in front of the maxillary notches, the vomer again makes its appearance as a narrow wedge inserted between the maxillae, and extending forward is visible from a ventral view of a distance of approximately 217 mm.

The distinguishing features of the squamosal are the large size and strength of the zygomatic arch, the short robust postglenoid process, and the slender glenoid process which is directed forward and downward in front of the tympano-periotic recess. A narrow groove for the external auditory meatus traverses the squamosal behind the postglenoid process. To the inside of the postglenoid process and in a position corresponding to the direction of this groove, the periotic was attached to the skull, and it in turn with the tympanic. The posterior border of the squamosal articulates with the exoccipital and between this suture and the transverse groove for the external auditory meatus, a rounded tuberosity is formed. The zygomatic process of this skull is rather large and has a slight outward curve. The lower surface is convex, with a decided upward and forward curve. The articular surface for the condyle of the mandible is an oval concavity, looking forward, inward, and downward. Internal to the glenoid fossa there is a sharply defined longitudinal depression, wide posteriorly and narrow anteriorly, which commences in front of the groove of the external auditory meatus and extends forward to the anterior margin of the squamosal. The lower margin of the squamosal, internal to this last-mentioned fossa, is prolonged downward and inward to form a thin plate.

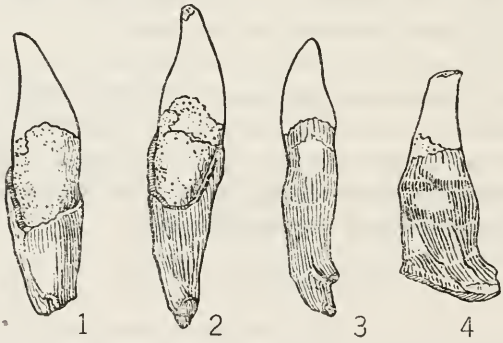
In this skull the line of separation between the exoccipitals and the basioccipital crosses the falcate process of the latter. Posteriorly, the exoccipitals are somewhat concave. The paroccipital process is relatively thick, its anterior aspect is roughened, and internally in conjunction with the descending plates of the basioccipital forms an incisure for the passage of the jugular vein.

Measurements of the skull

	mm.
Total length (occipital condyles to extremity of rostrum)	1,066
Length of rostrum (maxillary notches to tip of beak)	859
Breadth of skull across zygomatic processes of squamosal	240
Height of skull (between tip of descending process of basioccipital and nasals)	160
Height of skull (basisphenoid to nasals)	123
Greatest breadth of skull across supraorbital processes	236.5
Occipito-premaxillary length of skull (posterior margin of maxilla to tip of rostrum)	1,000
Greatest distance between outside margins of premaxillae opposite nasal passages	89
Greatest breadth of right premaxilla in front of nasal passages	30
Greatest breadth of left premaxilla at maxillary notch	27.5
Breadth of rostrum at maxillary notches	108
Greatest breadth of rostrum at extremity	14
Length of frontal plate of right maxilla	162
Greatest breadth of right maxilla posterior to nasals	66.5

Measurements of the skull—Continued.

	mm.
Distance between inner margins of maxillae at vertex	65.5
Greatest breadth of supraorbital process of frontal	71
Greatest thickness of frontal and maxilla combined near center of orbit	19.5
Maximum width of exposed portions of combined frontals on vertex	102
Greatest length of exposed portion of left frontal at vertex	27
Anteroposterior diameter of left nasal (along suture)	19
Transverse diameter of left nasal	24.5
Least breadth of cranium between temporal fossae	144.8
Greatest height of temporal fossa	56.5
Distance from vertex to upper margin of foramen magnum	96
Height of foramen magnum (crushed)	23
Width of foramen magnum (crushed)	35.5
Greatest distance between the outer margins of the occipital condyles	80.5
Greatest height of right condyle	49.5
Greatest breadth of right condyle	27.8
Greatest length of right zygomatic process	99.5
Breadth of skull across exoccipitals	186.8
Greatest vertical depth of skull in front of nares	83
Breadth across posterior ends of descending processes of basioccipital	92
Breadth across anterior ends of descending processes of basioccipital	54.4



TEETH

FIGS 1–4.—TEETH OF EURHINODELPHIS BOSSI. CAT. NO. 8842, U.S.N.M. × 3. 1. ANTERIOR VIEW OF TOOTH. 2. POSTERIOR VIEW OF A TOOTH. 3. POSTERIOR VIEW OF AN ANTERIOR TOOTH. 4. LATERAL VIEW OF A POSTERIOR TOOTH, APEX OF CROWN MISSING.

Unfortunately at least 12 of the posterior teeth and all of those in front of the tooth assumed to be the fifty-first on the left side are missing. Those that are present possess some interesting peculiarities. All of these teeth are compressed in an anteroposterior direction and progressively show a slight increase in height and thickness posteriorly. The teeth of *Priscodelphinus productus* as described by Du Bus [18] are apparently flattened in an anteroposterior

[18] Du Bus, B., Bull. Acad. Sci. de Belgique, ser. 2, vol. 34, No. 12, p. 492, 1872.

direction. A short neck or constriction below the enamel crown approximately 1.5 mm. wide accentuates the swollen appearance of the roots of these teeth. The surface of the enamel crown is nearly smooth. The inner and outer margins of the crown are rounded and not strongly carinate. As viewed from in front, the outer margins of the crowns are convex and the inner margins are concave. The apical portions of most of the teeth exhibit a tendency to incline or curve backward. A rudimentary second root is present on some of the teeth.

Measurements of the teeth in the left maxilla, in millimeters.

	Fourteenth	Seventeenth	Forty-ninth	Fifty-first
Height of enamel crown	9.4	9.8	7.3	6.6
Anteroposterior diameter of crown at base	3.4	3.3	2.7	2.6
Transverse diameter of crown at base	4.5	4.5	3.9	3.9

Mandible.—As restored the symphysial portion of each mandible is slightly longer than the free portion. The rami are firmly ankylosed throughout the symphysis and curve upward. This curvature (pl. 2) permits the teeth in the upper and lower jaws to interlock when the mouth is closed. All of the teeth are not located along the symphysis (pl. 3) for at least 14 were present on the ascending portion of the ramus. Judging from the alveoli, there were originally at least 50 teeth on the right ramus and 51 on the left. If the extremity had been preserved the figures given above would be increased. The symphysial portion of the combined lower jaws tapers anteriorly and at the same time the dorsoventral compression becomes more marked. Between the tooth rows the upper surface of the symphysis is relatively smooth. The depth of either mandible at the proximal end of the symphysis is nearly three times that at the extremity. The distance (118 mm.) from the symphysis to the last tooth is greater than the interval (80 mm.) between the opposite rows at the level of this tooth.

Back of the tooth row and on the internal face of the ramus there is an orifice for the large dental canal. Beyond this point the internal wall is incomplete and the ramus consists mainly of a thin shell or bone. A thin inwardly curved plate which extends downward from the superior margin of the coronoid portion of the ramus roofs the concavity above the dental canal. The external surface of the ramus in this region is convex. At a point 110 mm. behind the last tooth on the right ramus and 61 mm. behind the corresponding tooth on the left, the coronoid process and that portion of the jaw which lies above the level of the condyle is missing. Part of the coronoid process has been restored on the left ramus (pl. 3).

The superior margin of the ramus ascends gradually in an even curve, but because of crushing the inferior margin of the left ramus (pl. 2) is continued backward for a distance of 180 mm. in an essentially straight line and then slopes abruptly downward for 120 mm., curving upward beyond this point and terminating below the condyle. Originally the posterior margin of the angle may have been more nearly straight, for it is imperfect on both rami. By making due allowance for crushing and distortion it appears that the greatest depth (estimate 100 mm.) of the ramus at the coronoid was equal to less than one-third of the length of the jaw (341 mm.) posterior to the symphysis. The condyle is sub-quadrate in outline, directed backward and outward.

When viewed from the ventral side it becomes apparent that there is no well-defined longitudinal groove on either ramus. In its place there is a series of small channels which occupy the same relative position. On the right ramus there are at least seven foramina, and from these channels of varying lengths extend forward. Four foramina and their associated channels are present on the left ramus. Between these foramina and their channels the ventral surface of the combined rami is convex. The convexity of this surface is interrupted mesially by the suture following the line of fusion of the two rami.

Measurements of the mandible

	mm.
Length of right mandible as preserved (condyle to tip)	644.5
Length of right mandible, estimated (condyle to tip)	734.5
Length of left mandible as preserved (condyle to tip)	647
Length of left mandible, estimated (condyle to tip)	737.5
Greatest breadth of combined mandibles at extremity	15
Greatest depth of combined mandibles at extremity	10.4
Greatest breadth of combined mandibles at proximal end of symphysis	49.2
Greatest depth of combined mandibles at proximal end of symphysis	27.2
Greatest depth of right mandible at level of proximal alveolus	43.5
Greatest depth of left mandible at level of proximal alveolus	41.7
Breadth of mandible at base of coronoid	20.5
Greatest length of ankylosed symphysial portion of ramus as preserved	319
Greatest length of ankylosed symphysial portion of ramus, estimated	407
Length of right alveolar gutter as preserved	422
Length of left alveolar gutter as preserved	420
Depth of condyle of right mandible	33.2
Breadth of condyle of right mandible	29.5

SCAPULA

In contour and size this scapula corresponds in a general way with that of *Inia geoffrensis*. Posteriorly, most of the bladelike expanded region (pl. 6, fig. 1) above the neck, including the greater portion of

the vertebral margin, is missing. The external surface of this bone is slightly concave posterior to the spine, indicating a shallow postscapular fossa. The prescapular fossa is widest near the medial angle and rapidly narrows as it approaches the acromion process. The inferior margin of the scapula is divided into two deep notches by the long flattened acromion process. This process is relatively wide, expanded and irregularly rounded distally, and slightly twisted. In contrast to *Inia*, there is no distinct metacromial projection, and the coracoid process is relatively long and attenuate. This coracoid process (pl. 6, fig. 4) is inclined inward and directed downward from the head of the scapula. *Orcella* possesses a long coracoid process, but it is expanded distally. The neck of this scapula is rather broad and the glenoid cavity for the head of the humerus is shallow. What remains of the axillary margin shows that it turns abruptly backward near the level of the upper margin of the acromion process.

Measurements of the scapula (in millimeters)

Measurements	*Eurhinodelphis bossi* [1]	*Inia geoffrensis* [2]
Antero-posterior diameter of head of scapula	42.5	46
Extero-internal diameter of head of scapula	35.5	34
Posterior margin of head to tip of coracoid process	64.5	92
Posterior margin of head to tip of acromion	107.2	115
Posterior margin of head to median (anterior) angle	155	155
Distance from anterior (coracoid) margin of scapula to tip of acromion	58	66
Distance from tip of coracoid process to median (anterior) angle of scapula	123	137.5
Maximum thickness of scapula at base of acromion	21	21.5

[1] Cat. No. 8842, U. S. Nat. Mus. [2] Cat. No. 49582, U. S. Nat. Mus.

HUMERUS

The humerus is irregularly concave on the internal border, convex on the external, and except for a slight swelling near the lower margin of the lesser tuberosity the outline of the anterior border (pl. 12, fig. 4) is rather evenly concave. The broadly oval head is set off from the shaft by a well-marked neck, which, however, does not extend around upon the proximal surface. The head is large and projects slightly beyond the internal margin. It is barely visible when the humerus is viewed from in front, and when viewed from the side it is seen to lie below the lesser tuberosity, being separated from it laterally by a narrow groove. The deltoid crest is represented by a low swelling on the external face of the shaft. About halfway between the head and the inner trochlea there is a smaller but more evident protuberance on the angle formed by the internal and posterior faces. On the anterior face of the shaft there are two short elongate depressions that are almost continuous with one another, which commence near the upper margin of the inner

trochlea and extend obliquely upward to a point about 10 mm. below the center of the lower margin of the greater tuberosity. These depressions may mark the position of the *M. teres major* and the *MM. pectoralis and latissimus dorsi.* The posterior surface (pl. 12, fig. 5) is marked by a deep pit near the center of the shaft and below the head. In this pit the short head of the *M. triceps* probably had its origin. The inner trochlea is continued upward on the internal face of the shaft to correspond with the shape of the greater sigmoid cavity of the ulna. From an inferior view the capitulum or articular facet for the radius is seen to be parabolic in outline and to follow closely the contour of the lower end of the shaft. There is a distinct crest or ridge between the capitulum and the inner trochlea. Both of these articular facets are characterized by a transverse depression formed by a series of small foramina.

Measurements of left humerus

	mm.
Greatest length (greater tuberosity to lower margin)	104
Exterointernal diameter of shaft near middle	47
Anteroposterior diameter of shaft near middle	29.5
Exterointernal diameter of distal extremity of shaft	49.5
Anteroposterior diameter of proximal face of greater tuberosity	28
Dorsoventral diameter of head of humerus	49.5
Exterointernal diameter of head of humerus	41
Anteroposterior diameter of humerus through head	58

CERVICAL VERTEBRA

Only one of the cervical vertebrae was found and it (pl. 6, fig. 3) lacks the distal extremities of the lower transverse processes. For this reason it is difficult to determine which one of the posterior cervicals it actually represents. On making comparisons with the cervical series of other living and fossil porpoises there appears to be some grounds for believing that this vertebra is the fifth. The centrum is broadly oval in outline and relatively thin. The anterior epiphysis is complete, but a portion of the posterior one (pl. 6, fig. 6) is missing. The articular facets on the prezygapophyses are elongate, flattened, and slope obliquely inward. The neural arch is slender and bears a short spine. Only a rudiment of the upper transverse process persists, but the lower process is developed to an extraordinary degree. The lower transverse process is thin, broadly expanded, and unless it differed radically from other known porpoises was rather long. This process is directed obliquely backward and is perforated at the base by a large arterial canal. The postzygapophysial articular facets are obliquely situated on the lateral faces of backwardly projecting portions of the neural arch.

Measurements of fifth cervical vertebra

	mm.
Greatest depth (vertically) of vertebra (tip of neural spine to inferior face of centrum)	73.6
Greatest breadth of neural canal posteriorly	36.8
Height of anterior face of centrum	42.4
Breadth of anterior face of centrum	50.2
Height of posterior face of centrum	43.2
Breadth of posterior face of centrum	48.7
Length of centrum	25.6
Distance across vertebra between tips of the diapophyses	67.2
Distance across vertebra between tips of the transverse processes (parapophyses)	103.2+
Distance across vertebra between tips of prezygapophyses	47.6
Distance across vertebra between outside margins of the postzygapophysial facets	54.3
Distance between tip of left postzygapophysis and tip of left prezygapophysis	37.1
Minimum length of neurapophysis	11.1
Anteroposterior length of neural spine in a horizontal line immediately above the zygapophyses	10
Vertical height of neural spine (distance between superior margin of neural canal and tip of spine)	11.5
Maximum thickness of posterior epiphysis	5

DORSAL VERTEBRAE

Isolated vertebrae of fossil cetaceans are usually difficult to allocate when the full complement of the skeleton is unknown. Abel[19] has indicated the vertebral formula for *Eurhinodelphis* and has published a restoration of the entire skeleton. It is not known whether his observations were based on an associated skeleton, or whether a composite skeleton was constructed out of miscellaneous vertebrae from deposits in the vicinity of Antwerp. This formula in conjunction with the ribs found with the skull have been used in allocating these vertebrae.

From a study of recent types it might be argued that these seven dorsals are sufficiently characteristic for definite allocation. This is true so far as certain vertebrae are unquestionably anterior and others posterior. The prezygapophysial facets on the anterior dorsal of this porpoise are separated by a greater interval than any of the succeeding ones. Hence the postzygapophysial articular facets on each of the following dorsals tend to approximate one another to a greater degree in accordance with their position in the column. The centra of the dorsal and lumbar vertebrae increase

[19] Abel, O., Cetaceenstudien. I. Mitteilung: Das Skelett von Eurhinodelphis Cocheteuxi aus dem Obermiozan von Antwerpen. Sitz.-ber. kais. Akad. Wiss., Wien, Mathem.-naturw. Kl., vol. 118, Abt. 1, pp. 241–253, mit 1 pl., 1909.

in length from the first to the last. In view of the above, all allocations given below will remain tentative until a skeleton with associated vertebrae is found. Inasmuch as the first six ribs on the right side were preserved, it has been possible to determine definitely the position in the column of at least three of these dorsals.

The first and second dorsals are missing, but the third (pl. 8, fig. 1) is characterized by a rather long diapophysis, large oval prezygapophysial facets which lie in a slightly oblique plane, and a narrow neural spine. The neural arch (pl. 7, fig. 3) is low, relatively long, and on each side gives rise to a lateral process, the diapophysis. The articular facet for the tuberculum of the third rib is situated on the lower two-thirds of the outer face of the diapophysis. The neck of the diapophysis is constricted dorsoventrally between the facet and the neural arch. The postzygapophysial facets (pl. 7, fig. 6) are large, elongate, and slope obliquely inward. Both epiphyses are missing.

The neurapophyses of the fifth dorsal (pl. 7, fig. 2) are not as highly arched as the third, the diapophyses are shorter, and the neural spine is longer. No posterior epiphysis (pl. 7, fig. 5) is present and at least two-thirds of the anterior one is missing. The prezygapophysial facets are large and elongate, but they are nearer together than those of the third, and the inward slope is more oblique. The facet for the tuberculum of the rib (pl. 8, fig. 2) has shifted very slightly in position from that of the third, but it is somewhat broader. The postzygapophysial facets are nearly vertical in position. There is a trace of a median keel on this vertebra.

Unless the vertebra assumed to be the sixth (pl. 7, fig. 1) is abnormal, it will be difficult to explain certain features possessed by it. The centrum (pl. 8, fig. 3) is too short to follow after the fifth vertebra, but the neural spine is too high and long, and the prezygapophysial facets are too close together to assign a more anterior position to it. This vertebra may not belong to this porpoise. The diapophyses (pl. 7, fig. 4) are much shorter than those of either the fifth or the third, and the mesial dorsoventral constriction has largely disappeared.

The neural spine of the seventh dorsal is broken off near the base and the posterior epiphysis is missing. The prezygapophysial facets (pl. 7, fig. 7) are strongly concave, oblique in position, with thin raised inferior margins. The neural canal is more nearly circular than in any of the preceding vertebrae and the neurapophyses are slightly thinner. The diapophyses are short and their extremities are occupied by kidney-shaped facets for the tubercula. In the an-

terior dorsals the basal portions of the neural arches extend practically the entire length of the centrum, but in the ninth dorsal as well as in the more posterior ones they have receded from the posterior epiphyses. As will be noted from an examination of the figures, the backward projecting mesial portion of the neural arch becomes progressively shorter toward the posterior end of the series. The principal differences to be noted between this dorsal and the anterior ones are the length of the neural spine, the length of the centrum, the position and length of the diapophysis, and the close approximation of the postzygapophysial facets.

On account of the contact between the diapophysis and the parapophysis it appears probable that this vertebra (pl. 9, fig. 3) is the ninth dorsal. At least it is the last one in the dorsal series that retains a diapophysis. The most apparent differences between this vertebra and the preceding are the more noticeable constriction of the mesial portion of the centrum, the increase in length of the neural spine, and the narrowness of the neural canal. On the first two or three dorsals the diapophyses arise high up on the neural arch and when followed backward along the series they are seen to gradually shift their position until on the ninth dorsal they project from the base of the arch. In the third dorsal the distance from the inside margin of the neural arch to the tip of the diapophysis is 46.5 mm. The same measurement for the ninth dorsal is 18.5 mm.

On each side of the centrum of the third, fifth, and sixth dorsals, below the level of the neural arches and in front of the posterior epiphysis, there is a circular depression for the accommodation of the capitulum of the following rib. On the seventh dorsal there is a corresponding articular surface behind the anterior epiphysis and below the base of the neural arch.

The tenth dorsal (pl. 7, fig. 9) is characterized by a short broad parapophysis, high and narrow neural canal, long neural arch, and the small size of the postzygapophysial facets. The prezygapophysial facets of the third, fifth, and sixth dorsals are more nearly horizontal in position than are those of the ninth, tenth, and eleventh. The metapophyses project beyond the epiphyses in all of these dorsals, but the postzygapophyses do not. The anterior margin of the parapophysis on the tenth dorsal (pl. 9, fig. 2) is nearer to the anterior epiphysis than is the posterior margin with the other epiphysis, while in case of the eleventh dorsal (pl. 9, fig. 1) both margins near the base are almost equally distant from their corresponding epiphyses. Furthermore, the parapophyses of the eleventh dorsal tend to incline backward. On these last mentioned dorsals, the articular facets for the tubercula of the ribs are elongate and shallowly concave. These vertebrae differ among themselves in

the size of the neural canal in accordance with their position in the column. Anteriorly the neural canal is wider than high, but posteriorly (pl. 7, fig. 8) the reverse is true. The centra of all these dorsals are very slightly flattened dorsally and constricted mesially. The centra of the posterior dorsals are deeper and more rounded in cross section. There is a thin-edged longitudinal ridge or carina on the dorsal faces of the centra of the third, fifth, ninth, tenth, and eleventh dorsals.

Measurements of dorsal vertebrae (in millimeters)

	Third	Fifth	Sixth	Seventh	Ninth	Tenth	Eleventh
Greatest depth (vertically) of vertebra (tip of neural spine to inferior face of centrum)	130+	131+	110.2+	97+	129.7	143.2	132.7
Greatest depth of neural canal anteriorly	29.5	27	23.7	27.6	28	32.7	29.5
Greatest breadth of neural canal posteriorly	37.2	34.5	30.2	27.2	20.5	20.5	20.7
Height of anterior face of centrum	39	38.2	33.5+	41.4	45.2	47.5	48
Breadth of anterior face of centrum	42	43.4	46.4	46.7	53.6	54	53.6
Height of posterior face of centrum	38+	35.5	35+	41.7+	47	46.6	48+
Breadth of posterior face of centrum	53+	51.7	56.2	48.8+	50.2	52.8	54.2+
Length of centrum	[2] 36	[1] 44.2	[2] 35+	[1] 48.7	57.5	61.8	[1] 60.6
Distance across vertebra between tips of the diapophyses	114	96.8	84.5	83.3	57.2	-------	-------
Distance across vertebra between tips of transverse processes (parapophyses)	-------	-------	-------	-------	66	97	128.2
Distance across vertebra between tips of prezygapophyses	68	51.2	-------	45.7	29.4	28.3	-------
Distance across vertebra between outside margins of the postzygapophysial facets	53.7	33.4	28.6	18.5	16.5	14.3	11.7
Distance between tip of left postzygapophysis and tip of left prezygapophysis	58.7	65	49.5	73.2	66+	73.5+	82.2
Minimum length of neurapophysis	20.2	22.1	20.4	26	35.8	40.7	42.3
Anteroposterior length of neural spine in a horizontal line immediately above the zygapophyses	30.5	36	36	41	45.5	45	49.2
Anteroposterior diameter of right diapophysis at extremity	21.4	32.7	25.5	21	15.4	-------	-------
Anteroposterior diameter of right parapophysis at extremity	-------	-------	-------	-------	-------	34.3	33.3
Vertical height of neural spine (distance between superior margin of neural canal and tip of spine)	61+	62.1	49.7	-------	52	66.8	55.5

[1] One epiphysis missing. [2] Both epiphyses missing.

LUMBAR VERTEBRAE

Before taking up in detail the characteristics of the three lumbars found with the skull, mention should be made that on the basis of Abel's restoration they appear to represent the sixth, eighth, and tenth in the series. The right parapophysis of the sixth lumbar (pl. 8, fig. 5) is broken off near the base. Beyond the lengthening of the neural spine and a slight narrowing of the neural canal, there is no marked difference between the eighth (pl. 8, fig. 4) and sixth lumbars. The sixth (pl. 9, fig. 5) lacks the posterior epiphysis and the eighth (pl. 9, fig. 4) lacks both epiphyses. The prezygapophyses of both lumbars are damaged, but those of the eighth are the best preserved. The right parapophysis, the posterior epiphysis, the neural arch and its associated structures are missing on the tenth lumbar (pl. 9, fig. 6). On the sixth and eighth lumbars the neural

arches are not as long anteroposteriorly as those of the eleventh dorsal and are characterized by curved anterior and posterior margins. The neural canals of these lumbars are narrow, high, and roughly triangular in outline. In cross section the centra of all three lumbars are roughly pentagonal in outline. The transverse processes or parapophyses are thin, relatively narrow, long, and incline downward. The neural spines appear to rake backward to a more noticeable degree than those of the posterior dorsals. The prezygapophysial facets are situated on the internal faces of the obliquely directed laminae which arise from the anterior margins of the neural arches. The postzygapophysial facets are small and are situated on the lateral faces of the neural spine at the posteroinferior angle. There is a well-defined ventral carina on the eighth and tenth lumbars.

Measurements of lumbar vertebrae (in millimeters)

	Sixth	Eighth	Tenth
Greatest depth (vertically) of vertebra (tip of neural spine to inferior face of centrum)	180.2	157.5+	----------
Greatest depth of neural canal anteriorly	33.8	33.7	----------
Greatest breadth of neural canal posteriorly	18.7	19.5	11.2
Height of anterior face of centrum	52.5+	50.7	----------
Breadth of anterior face of centrum	56.8+	55	58
Height of posterior face of centrum	52.3+	48.5	[1] 56.5
Breadth of posterior face of centrum	55.3+	54.7+	[1] 60
Length of centrum	[1] 66	[1] 65.5	[2] 73.5
Distance across vertebra between tips of parapophyses	193.3	[2] 194	[2] 194
Distance across vertebra between tips of prezygapophyses	27.7+	----------	----------
Distance across vertebra between outside margins of postzygapophysial facets	6.2	8.4	----------
Distance between tip of right postzygapophysis and tip of right prezygapophysis	84	80.2	----------
Minimum length of neurapophysis	40	40.5	----------
Anteroposterior length of neural spine in a horizontal line immediately above the zygapophyses	44.5	50	----------
Anteroposterior diameter of left parapophysis at extremity	23.5	24	24.2
Vertical height of neural spine (distance between superior margin of spinal canal and tip of spine)	95.2	80.5+	----------

[1] Epiphysis missing. [2] Estimate.

CAUDAL VERTEBRAE

It may seem unusual that these five caudal vertebrae are so widely separated from each other in the column, but on the basis of Abel's figure they will have to be assigned somewhere near the following positions. The epiphyses of three of these caudals are nearly circular, even though the centra are irregularly pentagonal. Although the transverse processes of the fifth caudal (pl. 12, fig. 1) are broken off near the base, it is evident that these processes were somewhat shorter than those of the tenth lumbar. The lateral faces of the centrum (pl. 11, fig. 1) both above and below these processes are concave. The neural arches are high and long anteroposteriorly. The neural spine is short and its posterior margin curves forward. The neural canal is very narrow in proportion to its height. Large protruding postero-inferior facets for the chevrons (pl. 13, fig. 1)

are present in front of the posterior epiphysis, but the antero-inferior ones are somewhat smaller. Between these facets the inferior surface of the centrum is grooved.

The neural arches of the eighth caudal (pl. 10, fig. 2) are rather low and the neural canal is small and ovoidal. Short transverse processes (pl. 12, fig. 2) are present; their extremities are obliquely truncated. Both pairs of inferior facets for the chevrons (pl. 13, fig. 2) are situated on prominent protuberances. These articular surfaces are obliquely placed on the protuberances and slope upward and outward. The depression between these facets is deeper than that on the fifth caudal. On this caudal and on the tenth the prominence of these protuberances in conjunction with the outward curvature of the rudimentary neural arches emphasize the concavities above and below the transverse processes.

The tenth caudal (pl. 10, fig. 3) is characterized by a lower neural arch, smaller neural canal, and rudimentary transverse processes. In cross section this vertebra would appear almost pentagonal. Behind the transverse process (pl. 11, fig. 3) there is a well-defined groove which curves downward and reaches the ventral face through the depression between the anterior and posterior facets for the chevron bones. Between these facets (pl. 13, fig. 3) there is a broad elongate concavity. This vertebra is noticeably broader anteriorly than posteriorly. Both epiphyses are missing.

As compared with the tenth caudal, the fourteenth (pl. 10, fig. 4) is somewhat shorter, more rounded, and lacks a complete neural arch. Near the middle and inside of the low ridges which represent the rudiments of the neural arch, there is an orifice for each vertebrarterial canal. No trace of the transverse process is retained on either lateral face of the centrum. In its place there is a mesial depression which corresponds in function with the more evident groove on the tenth caudal. No facets for the chevrons are present.

The eighteenth caudal is strongly flattened dorsoventrally. The anterior epiphysis is thick with a convex articular face. The posterior epiphysis is missing. Near the middle of the dorsal face there are a pair of orifices for vertebrarterial canals which pierce the centrum in a dorsoventral direction and emerge ventrally. There is an oval longitudinal depression between their orifices on the ventral face. The centrum is irregular in outline and is more noticeably porous than any of the preceding caudals. The lateral faces of this caudal are nearly vertical in contrast to the rounded appearance of the centra of the anterior caudals. The anterior and posterior faces of the centrum swell out and consequently the epiphyses of this caudal acquire a slightly different shape from the others.

Measurements of caudal vertebrae (in millimeters)

Measurements	Fifth	Eighth	Tenth	Four-teenth	Eigh-teenth
Greatest depth (vertically) of vertebra (tip of neural spine to inferior face of centrum)	142	93	82	54.6	30
Greatest depth of neural canal anteriorly	28	--------	8	--------	--------
Greatest breadth of neural canal posteriorly	8.5	8.7	7.2	--------	--------
Height of anterior face of centrum	60.5	61.7	63	61.2	29
Breadth of anterior face of centrum	67.7	64.7	61.5	53	35.7
Height of posterior face of centrum	66	64	65	47	
Breadth of posterior face of centrum	67	58.6	52.6	44.3	--------
Length of centrum	87.5	86.5	[1] 69	61.6	[1] 45
Distance across vertebra between tips of the parapophyses	--------	92.2	66	--------	--------
Distance across vertebra between tips of the prezygapophyses	35	38.2	30.5	--------	--------
Minimum length of neurapophysis	41	46	51	--------	--------
Anteroposterior length of neural spine in a horizontal line immediately above the zygapophyses	31.2	--------	--------	--------	--------
Vertical height of neural spine (distance between superior margin of neural canal and tip of spine)	53	--------	--------	--------	--------
Maximum thickness of posterior epiphysis	9.3	--------	--------	--------	--------

[1] Epiphysis missing.

RIBS

All the ribs found with this specimen are imperfect. The proximal portions of 10 ribs are sufficiently well preserved to permit accurate description. The extremities only of two other ribs were found. This fossil porpoise probably possessed 11 pairs of ribs of which the first pair are the shortest. When these ribs are arranged in what appears to be their normal position, the external curvature of the anterior ribs is seen to be less pronounced than that for those near the posterior end of the series.

The neck of the first rib (pl. 14, fig. 1) is flattened, relatively deep, and bears a short quadrangular-shaped capitulum at the extremity. The tuberculum is subovoidal, concave, with a noticeable mesial depression. The shaft is also flattened.

Only the neck of the second rib (pl. 14, fig. 2) was found and it is also deep and rather short, but the capitulum is larger and more ovoidal than that of the first rib. The tuberculum is also ovoidal, but is not so noticeably depressed mesially. There is a concavity on the posterior face of the neck.

The neck of the third rib (pl. 14, fig. 3) is narrower than that of the second, with an evident constriction. The capitulum is trapezoidal in outline. The tuberculum is elongate, nearly subtriangular in outline, and somewhat depressed mesially. Between the tuberculum and the angle the external face of this rib is flattened, with a flaring posterior margin.

In depth the neck of the fourth rib (pl. 14, fig. 4) is about equal to the breadth. The increase in length of the neck corresponds to the change in relative position of the facets on the corresponding vertebrae for the capitulum and tuberculum. These facets are roughly triangular in outline. The external face of this rib is flattened with projecting anterior and posterior margins. This flattened

area commences 23.5 mm. below tuberculum and extends downward for a distance of 38 mm.

The neck of the fifth rib (pl. 14, fig. 5) is also narrow, with its depth greater than its breadth. The tuberculum is sub-triangular in outline and about equally as long as broad. The internal margin of this articular facet rolls over upon the shaft and the external face of the shaft is not so noticeably flattened as on the fourth rib.

The neck of the sixth rib (pl. 14, fig. 6) is even narrower, but the depth and breadth are about equal. The capitulum and tuberculum are about equal in area. As in case of the fifth rib, the internal margin of the tuberculum likewise rolls over upon the shaft, and the external face is more rounded.

On the ninth rib (pl. 14, fig. 7) the facets for articulation with the rudimentary diapophysis and parapophysis are combined into a single articular head. The tenth rib (pl. 14, fig. 8) is characterized by having a long narrow articular head for the parapophysis. Near the middle the width and depth of the shaft are about equal. All the ribs thin out near their lower extremities.

Measurements of ribs in millimeters

Measurements	First rib right	Second rib right	Third rib right	Fourth rib right	Fifth rib right	Sixth rib right	Ninth rib right	Tenth rib left	Third rib left	Fifth rib left
Total length in a straight line	[2] 149.5	--------	[1] 186.3	[2] 265.7	[1] 174.3	[2] 283.5	[1] 248.5	[2] 293.6	[1] 112.2	[1] 120
Greatest breadth of shaft at angle	25.7	--------	24.3	18.2	17	18.3	14.8	16.3	19.3	16.8
Distance between external margin of tuberculum and anterior margin of capitulum	50.6	--------	47.5	46.8	--------	43.2	25.1	--------	46.1	43.2
Greatest thickness of shaft near the middle	10.2	--------	9.5	10.8	10.6	10.8	11.7	10.2	10.1	11.7
Greatest diameter of articular facet on head of rib	13.8	18.7	16.7	14.3	--------	16.3	[3] 25.2	--------	13.7	14.5
Greatest diameter of articular facet on tubercle of rib	30.2	--------	21.9	21	17.6	17.7	--------	--------	20.7	17.6
Least breadth of neck	21.4	20.2	12.7	11.1	10.6	9.9	--------	--------	10.8	10

[1] Capitulum to extremity.
[2] Tuberculum to extremity.
[3] Combined facets for diapophysis and parapophyses.

INDIVIDUAL 2

Skull, Cat. No. 10714, Section of Vertebrate Paleontology, United States National Museum.

Some difficulty was encountered while excavating around this skull in preparation for its removal from the cliff, and unfortunately it was fractured in several places. The top of the cranium (pl. 15, fig. 1) and most of the rostrum was removed in good condition.

All of the material that could be found was brought to Washington, and thanks to the skillful manner in which the fragments have been fitted together by Norman H. Boss, a fair skull was made available for study. In its present condition the loss of the extremity of the rostrum is the most noticeable defect. Fortunately the external margins of the maxillae above the temporal fossae are perfect and supplement the skull of individual 1 (Cat. No. 8842, U. S. Nat. Mus.). The premaxillae were damaged in the region of the nasal passages and the missing portions have been restored. There is an unusually deep external groove leading backward from the premaxillary foramen. The nasal bones are in contact mesially for a distance of 25 mm. The exposed portions of the frontals on the vertex are relatively narrow and are not noticeably longer than the nasals. The dorsal surface of the vertex (pl. 16, fig. 1) is higher than the adjoining upper margin of the supraoccipital. On the left side the posterior half of the supraorbital process is missing. The left zygoma lacks the postglenoid process and a portion of its anterior extremity. Except for the anterior end, the right zygoma is lost. In addition the lower half of the left exoccipital and the adjoining portion of the descending plate of the basioccipital are missing. In the region of the temporal fossae, both parietals are absent. The pterygoids (pl. 15, fig. 2) are completely destroyed on the left side. On the right side, a small portion of the internal plate of the pterygoid which abuts against the basisphenoid is present; the remainder of this plate and its external reduplication are missing. In consequence of the loss of the external plate of the pterygoid, the optic canal is exposed near its origin. Because of the absence of the mesethmoid and the loss of the internal plates of the pterygoids, the nasal passages do not appear as small as they do in better preserved skulls. The foramina (pl. 5) in the right tympano-periotic recess are well preserved; those on the left side are more or less mutilated. A broad strip of the supraoccipital extending from side to side immediately above the foramen magnum is also missing. The posterior styliform processes of the jugals are missing on both sides, but their anterior extremities are present. For the most part the septa between the alveoli are obliterated.

Occurrence.—Near latitude 38° 40′ north, and longitude 76° 41′ west, South Chesapeake Beach, on the western shore of Chesapeake Bay, Calvert County, Maryland. Shown on Patuxent Quadrangle or Patuxent Folio, No. 152, United States Geological Survey.

Horizon.—This skull came from Shattuck's zone No. 3 of the Calvert Miocene formation of Maryland. It was discovered and excavated by William Palmer in September, 1920.

Measurements of the skull

	mm.
Total length (occipital condyles to extremity of rostrum)	794
Length of rostrum (maxillary notches to tip of beak)	587
Breadth of skull across zygomatic processes of squamosal	239
Height of skull (between tip of descending process of basioccipital and nasals	179
Height of skull (basisphenoid to nasals)	140
Occipito-premaxillary length of skull (posterior margin of maxilla to tip of rostrum)	743
Greatest breadth of skull across supraorbital processes	224
Greatest distance between external margins of premaxillae at level of nasal passages	108
Greatest breadth of left premaxilla in front of nares	47.5
Greatest breadth of left premaxilla at maxillary notch	46.5
Breadth of rostrum at maxillary notches	126.5
Greatest length of frontal plate of right maxilla	164
Greatest breadth of right maxilla posterior to nasals	87.5
Distance between inner margins of maxillae at vertex	66
Greatest antero-posterior length of supraorbital process of right frontal	68.5
Greatest thickness of frontal, lachrymal, and maxilla combined in front of right orbit	30
Maximum width of exposed portions of combined frontals on vertex	98
Greatest length of exposed portion of left frontal at vertex	32.5
Anteroposterior diameter of left nasal (along suture)	25.5
Transverse diameter of left nasal	26
Distance from vertex to upper margin of foramen magnum	102.5
Height of foramen magnum	39
Breadth of foramen magnum	36
Greatest distance between outer margins of occipital condyles	89.8
Greatest height of right condyle	51.2
Greatest breadth of right condyle	32.7
Greatest length of left zygomatic process (as preserved)	78.8
Breadth of skull across exoccipitals	201
Greatest vertical depth of skull in front of nares	94
Breadth across posterior ends of descending processes of basioccipital	107
Breadth across anterior ends of descending processes of basioccipital	61
Breadth of skull across zygomatic processes of squamosals	237

INDIVIDUAL 3

Skull, Cat. No. 10464, Section of Vertebrate Paleontology, United States National Museum.

Although the skull from a dorsal view (pl. 16, fig. 2) appears to be in a fair state of preservation, this condition unfortunately does not extend to structures not visible from this view. The extremity of the rostrum, the teeth, and the ear bones are missing. On the left side of the rostrum in the groove between the maxilla and the premaxilla and at a point 248 mm. in front of the maxillary notch, there is a large foramen. Notwithstanding the fracture across the base of the rostrum, the premaxillae were little damaged by that accident. The mesethmoid is present, and although there is a well-

defined pit on each side of it below the nasals the frontal fontanelle was completely closed and no trace can be found of foramina which would afford passage for the olfactory nerves through the ectethmoids. To make certain that these foramina were not hidden by matrix, that portion of the bone which incloses the pit on the left side was removed and carefully examined. The jugals and their long styliform processes are missing. Both lachrymals are preserved even though the forward projecting processes of the horizontal plates of the maxillae which normally overlie them are broken off near the anterior margin of the supraorbital processes of the frontals. The right and left supraorbital processes are essentially complete except for the loss of their postorbital projections. The outer margin of the maxilla above the right temporal fossa is imperfect. The nasals are more rounded than those of the other skulls. On each side above the foramen magnum there is a vacuity in the supraoccipital approximately 38 mm. wide which has resulted from some accident, probably from the dislodgment of the exoccipitals. Between these vacuities there is a median strip of the supraoccipital averaging 31 mm. in width which maintains the correct relations between the base and the top of the skull. Both exoccipitals are lost. All of the right and left squamosal bones, including their zygomatic processes, are missing. The extremities of the alisphenoids are damaged. The descending plates of the basioccipital are not complete. No remnants of the pterygoids can be found on either side. Both parietals are lost.

Occurrence.—Near latitude 38° 40′ north, and longitude 76° 41′ west, South Chesapeake Beach, on the western shore of Chesapeake Bay, Calvert County, Maryland. Shown on Patuxent Quadrangle or Pateuxent Folio, No. 152, United States Geological Survey.

Horizon.—The skull was found by F. W. True on March 30, 1907, in clay on the shore at a point immediately north of the Sunset Hotel, Chesapeake Beach. It lay in bluish clay about a foot above the beach. The skull was turned upside down, and the right frontal bone was exposed. The long axis of the skull was at an angle to the face of the bank. The skull belongs to Shattuck's zone No. 5.

Measurements of the skull

	mm.
Total length (occipital condyles to extremity of the rostrum)	842
Length of rostrum (maxillary notches to tip of beak)	649
Height of skull (basisphenoid to nasals)	118
Greatest breadth of skull across supraorbital processes of frontals (anteriorly)	196.5
Occipito-premaxillary length of skull (posterior margin of maxilla to tip of rostrum)	803
Greatest distance between outside margins of premaxillae opposite nasal passages	95

Measurements of the skull—Continued

	mm.
Greatest breadth of left premaxilla in front of nares	41
Greatest breadth of left premaxilla at maxillary notch	29.2
Breadth of rostrum at maxillary notches	118
Breadth of rostrum at extremity	19.2
Length of frontal plate of left maxilla	152.3
Greatest breadth of left maxilla posterior to nasals	66
Distance between inner margins of maxillae at vertex	56.8
Greatest thickness of frontal and maxilla combined near center of orbit	17.3
Maximum width of exposed portions of combined frontals on vertex	75
Greatest length of exposed portion of left frontal at vertex	25
Anteroposterior diameter of left nasal (along suture)	21.5
Greatest anteroposterior diameter of right nasal	28.3
Transverse diameter of right nasal	21.2
Distance from vertex to upper margin of foramen magnum	102.7
Greatest height of left condyle	41
Greatest breadth of left condyle	26

INDIVIDUAL 4

Skull, Cat. No. 10711, Section of Vertebrate Paleontology, United States National Museum.

From time to time large masses of clay are dislodged from the cliffs by the undercutting action of the tides. Whenever remains of fossil cetaceans are thrown down in this manner they are usually broken up either by the fall or by being rolled about in the water. It is not known whether this skull was broken in this way or at the time of excavation. At any event the skull was fractured in many places and was restored to its present condition before it was purchased by the museum. It is listed here on account of the large size of the braincase. On the basis of comparative measurements taken from the other skulls it is apparent that only the proximal one-third of the rostrum is preserved. As will be noted from an examination of plate 17, the outer margins of the maxillae anterior to the maxillary foramina have been broken off along the external margins of the premaxillae. The thin horizontal plate of the left maxilla is fairly well preserved above the temporal fossa and retains most of its original external margin, but on the right side posterior to the supraorbital process a large section of the maxilla is missing, exposing the temporal fossa.

A section of the right premaxilla, 46 mm. in length, is missing above the nasal passage and the inner margin of the left is imperfect in the corresponding region. Both nasal bones are lost. A very narrow strip of the combined frontals is exposed on the vertex. Part of the thin horizontal plate of the maxilla which overlies the right supraorbital process is missing. The slender process of the maxilla which projects forward and overlies the left lachrymal was

broken off near its origin. The anterior half of the outer border of the right supraorbital process is missing.

The right zygoma is nearly perfect, but the left one is fractured behind the postglenoid process. In the right temporal fossa a small fragment of the parietal remains. The alisphenoid is considerably damaged on both sides, so much so that most of the foramina are obliterated. The outer and lower extremities of both exoccipitals are damaged. The supraoccipital is lost except for a small piece attached to the right frontal. From a ventral view the vomer is seen to be greatly constricted between the nasal passages, forming a narrow trough. The internal plate of the pterygoid and its external reduplication are completely missing on both sides. The lachrymals and jugals are missing. The palatines are damaged along their external margins. The mesethmoid is lost. No septa between the alveoli are preserved.

Occurrence.—No definite information regarding the place of discovery of this specimen can be found in any of the notes left by William Palmer. All that is known is that it was obtained from the Calvert cliffs, on the western shore of Chesapeake Bay, at some point between Dare's wharf and Chesapeake Beach. The clay matrix and mollusca within the brain cavity show that the specimen came from the Calvert formation.

Measurements of the skull

	mm.
Total length (occipital condyles to extremity of rostrum)	497.5
Length of rostrum (maxillary notches to extremity)	287.5
Breadth of skull across zygomatic processes of squamosals	245
Height of skull (between tip of descending process of basioccipital and frontals)	177
Height of skull (basisphenoid to frontals)	131
Greatest breadth of skull across supraorbital processes	250
Greatest distance between outside margins of premaxillae opposite nasal passages	111
Greatest breadth of left premaxilla in front of nasal passages	44
Breadth of rostrum at maxillary notches	126.4
Length of frontal plate of left maxilla	169
Greatest breadth of left maxilla at level of posterior margin of supraorbital process of frontal	100
Distance between inner margins of maxillae at vertex	55
Greatest anteroposterior length of left supraorbital process of frontal	76.2
Maximum width of exposed portions of combined frontals on vertex	92
Greatest length of exposed portion of left frontal on vertex	25
Distance from vertex to lower margin of foramen magnum	
Breadth of foramen magnum	40.5
Greatest distance between outer margins of occipital condyles	92.2
Greatest breadth of right condyle	35
Greatest length of left zygomatic process, as preserved	86.4
Breadth of skull across exoccipitals	203.5
Breadth of skull across zygomatic processes of squamosals	245

EXPLANATION OF PLATES

Eurhinodelphis bossi, new species. Type, Cat. No. 8842, Section of Vertebrate Paleontology, United States National Museum. Calvert formation, western shore of Chesapeake Bay, about 2 miles south of Chesapeake Beach, Calvert County, Maryland. Collected by Norman H. Boss, August, 1918.

PLATE 1

Type skull of *Eurhinodelphis bossi*, new species. About one-sixth natural size. Fig. 1. Dorsal view. Fig. 2. Ventral view. Abbreviations: *Bo.*, basioccipital; *C.*, condyle; *Ex. O.*, exoccipital; *Fo. c.*, condyloid foramen; *Fo. inf.*, infraorbital foramen; *Fo. l. p.*, foramen lacerum posterius; *Fo. max.*, maxillary foramen; *Fr.*, frontal; *Ha.*, hamular process of pterygoid; *Ju.*, jugal; *La.*, lachrymal; *Max.*, maxilla; *Mes.*, mesethmoid; *Na.*, nasal; *Op. c.*, optic canal; *Pal.*, palatine; *Pmx.*, premaxilla; *Pt.*, pterygoid; *So.*, supraoccipital; *S. or. pr.*, supraorbital process of frontal; *St. pr.*, styliform process of jugal; *V.*, vomer; *Zyg.*, zygomatic process of squamosal.

PLATE 2

Lateral view of type skull of *Eurhinodelphis bossi*, new species. About one-sixth natural size.

PLATE 3

Dorsal view of type mandible of *Eurhinodelphis bossi*, new species. About three-tenths natural size.

PLATE 4

Posterior view of type skull of *Eurhinodelphis bossi*, new species. About one-half natural size.

PLATE 5

Ventral view of skull of *Eurhinodelphis bossi*. Individual 2, Cat. No. 10714, United States National Museum. About five-sevenths natural size. View showing foramina within the tympano-periotic recess and the relations of the various elements composing the ventral face of the skull. The external reduplication of the pterygoid and the orbitosphenoid are missing. Hence the outer wall of the nasal passage is also missing. Abbreviations: *Al.*, alisphenoid; *Bo.*, basioccipital; *Bo. pl.*, descending plate or falcate process of the basioccipital; *C.*, condyle; *Ex. o.*, exoccipital; *Fo. inf.*, infraorbital foramen; *Fr.*, frontal; *Ju.*, jugal; *La.*, lachrymal; *Max.*, maxilla; *Op. c.*, optic canal; *Pal.*, palatine; *Pt.*, pterygoid; *S. or pr.*, supraorbital process of frontal; *Sq*, squamosal; *V.*, vomer; *Zyg.*, zygomatic process of squamosal; 1, carotid canal; 2, passage for mandibular branch of trigeminal nerve; 3, furrow for mandibular branch of trigeminal nerve; 4, foramen lacerum medius; 5, jugular foramen or foramen lacerum posterius, compartment for nerves; 6, jugular foramen or foramen lacerum posterius, compartment for vein; 7, condyloid foramen or hypoglossal canal in jugular incisure.

PLATE 6

Views of scapula and vertebrae of *Eurhinodelphis bossi*. Fig. 1, dorsal or external view of left scapula (about three-sevenths natural size); Fig. 2, posterior epiphysis of fifth caudal (about two-fifths natural size); Fig. 3, anterior view of fifth cervical (about one-half natural size); Fig. 4, ventral or internal view of left scapula (about three-sevenths natural size); Fig. 5, internal surface of epiphysis of an anterior caudal (about two-fifths natural size); Fig. 6, posterior view of fifth cervical (about one-half natural size).

PLATE 7

Views of dorsal vertebrae of *Eurhinodelphis bossi.* About three-tenths natural size. Fig. 1, anterior view of sixth dorsal vetebra ; Fig. 2, anterior view of fifth dorsal vertebra ; Fig. 3, anterior view of third dorsal vertebra ; Fig. 4, posterior view of sixth dorsal vertebra ; Fig. 5, posterior view of fifth dorsal vertebra ; Fig. 6, posterior view of third dorsal vertebra ; Fig. 7, anterior view of seventh dorsal vertebra ; Fig. 8, anterior view of eleventh dorsal vertebra ; Fig. 9, anterior view of tenth dorsal vertebra.

PLATE 8

Views of dorsal and lumbar vertebrae of *Eurhinodelphis bossi.* Figs. 1–3, about three-sevenths natural size ; Figs. 4–5, about one-third natural size. Fig. 1, lateral view of third dorsal vertebra ; Fig. 2, lateral view of fifth dorsal vertebra ; Fig. 3, lateral view of sixth dorsal vertebra ; Fig. 4, anterior view of eighth lumbar vertebra ; Fig. 5, posterior view of sixth lumbar vertebra.

PLATE 9

Lateral views of posterior dorsal and lumbar vertebrae of *Eurhinodelphis bossi.* About two-fifths natural size. Fig. 1, eleventh dorsal vertebra ; Fig. 2, tenth dorsal vertebra ; Fig. 3, ninth dorsal vertebra ; Fig. 4, eighth lumbar vertebra ; Fig. 5, sixth lumbar vertebra ; Fig. 6, tenth lumbar vertebra.

PLATE 10

Views of caudal vertebrae of *Eurhinodelphis bossi.* About three-fifths natural size. Fig. 1, anterior view of fifth caudal vertebra ; Fig. 2, anterior view of eighth caudal vertebra ; Fig. 3, anterior view of tenth caudal vertebra ; Fig. 4, dorsal view of fourteenth caudal vertebra ; Fig. 5, anterior view of fourteenth caudal vertebra.

PLATE 11

Lateral views of caudal vertebrae of *Eurhinodelphis bossi.* About three-fifths natural size. Fig. 1, fifth caudal vertebra ; Fig. 2, eighth caudal vertebra ; Fig. 3, tenth caudal vertebra.

PLATE 12

Views of caudal vertebrae and left humerus of *Eurhinodelphis bossi.* About three-fifths natural size. Fig. 1, dorsal view of fifth caudal vertebra ; Fig. 2, dorsal view of eighth caudal vertebra ; Fig. 3, dorsal view of tenth caudal vertebra ; Fig. 4, internal view of left humerus ; Fig. 5, posterior view of left humerus.

PLATE 13

Ventral views of caudal vertebrae of *Eurhinodelphis bossi.* About three-fifths natural size. Fig. 1, fifth caudal vertebra ; Fig. 2, eighth caudal vertebra ; Fig. 3, tenth caudal vertebra.

PLATE 14

Lateral views of ribs of *Eurhinodelphis bossi.* About nine-twentieths natural size. Fig. 1, first rib, right side ; Fig. 2, second rib, right side ; Fig. 3, third rib, right side ; Fig. 4, fourth rib, right side ; Fig. 5, fifth rib, right side ; Fig. 6, sixth rib, right side ; Fig. 7, ninth rib, right side ; Fig. 8, tenth rib, right side ; Fig. 9, third rib, left side ; Fig. 10, fifth rib, left side.

Plate 15

Skull of *Eurhinodelphis bossi.* Individual 2, Cat. No. 10714, United States National Museum. About one-fifth natural size. Fig. 1, dorsal view; Fig. 2, ventral view.

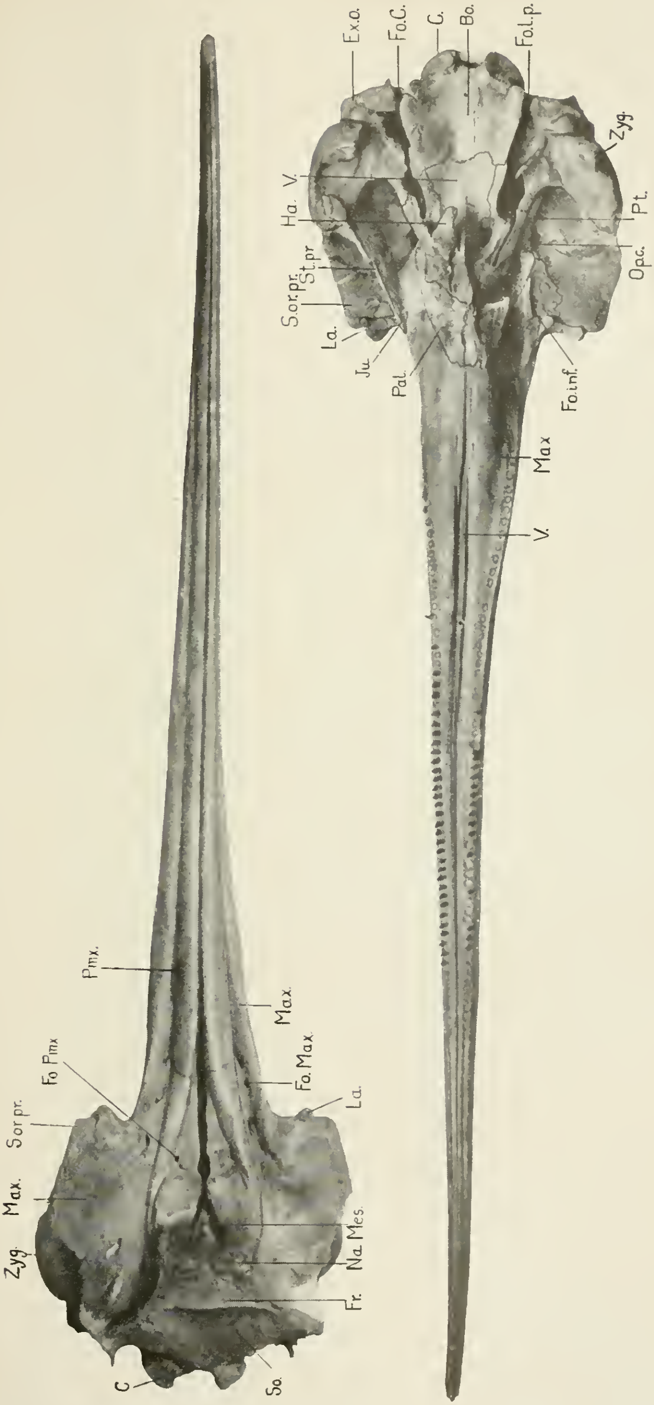
Plate 16

Fig. 1. Lateral view of skull of *Eurhinodelphis bossi.* Individual 2, Cat. No. 10714, United States National Museum. About one-fifth natural size.

Fig. 2. Dorsal view of skull of *Eurhinodelphis bossi.* Individual 3, Cat. No. 10464, United States National Museum. About one-fifth natural size.

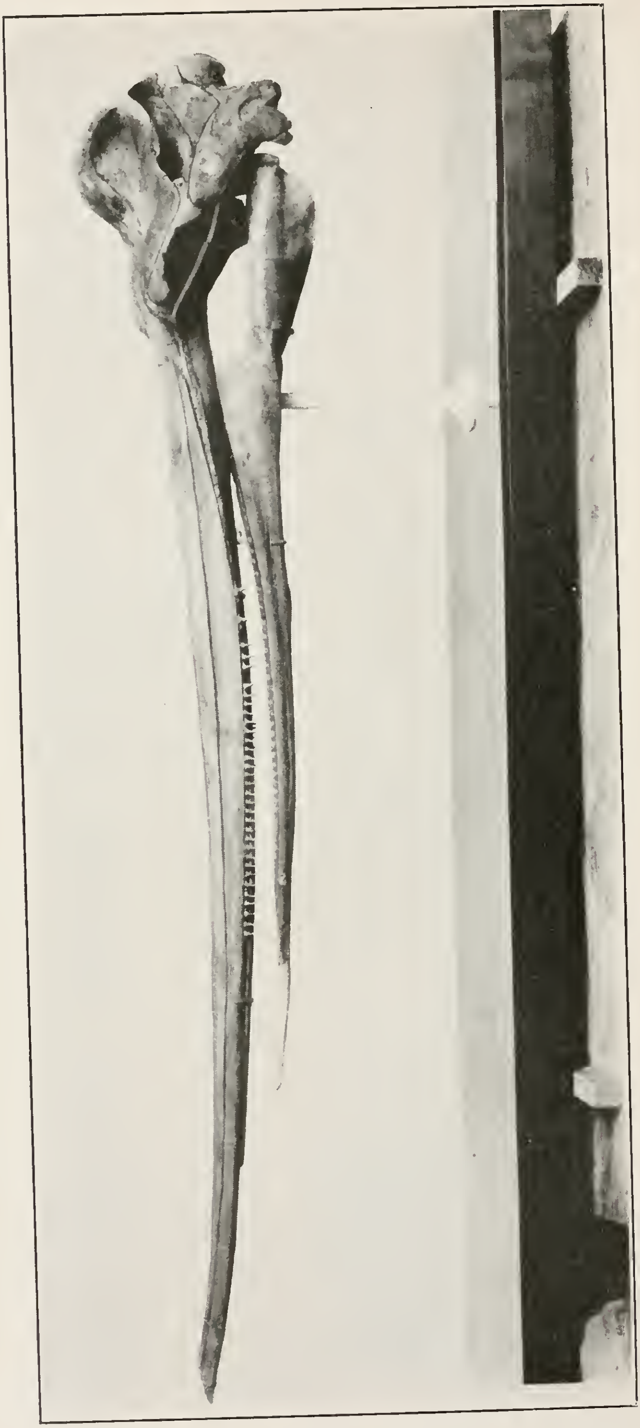
Plate 17

Lateral view of skull of *Eurhinodelphis bossi.* Individual 4, Cat. No. 10711, United States National Museum. About one-third natural size.



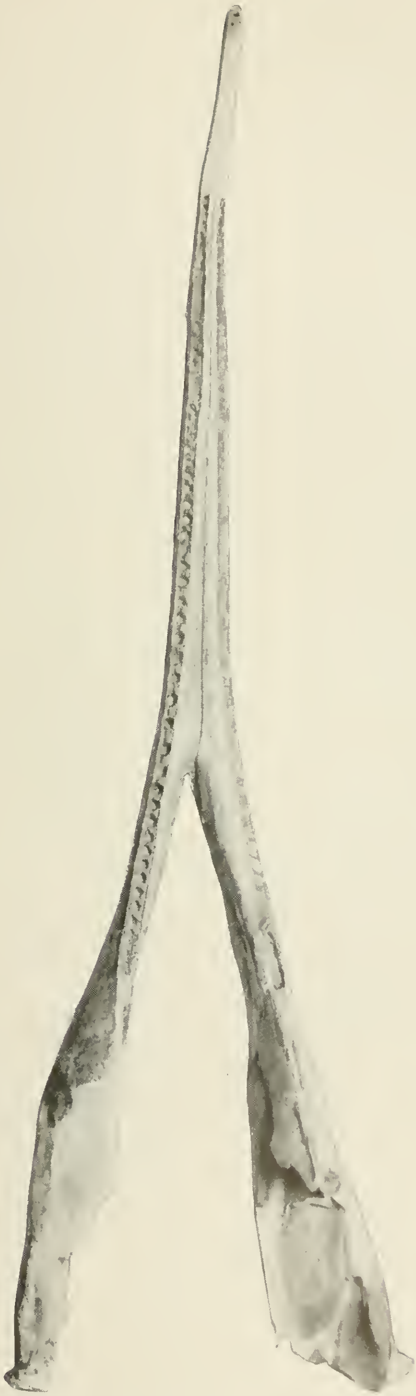
DORSAL AND VENTRAL VIEWS OF TYPE SKULL OF EURHINODELPHIS BOSSI

FOR EXPLANATION OF PLATE SEE PAGE 38



LATERAL VIEW OF TYPE SKULL OF EURHINODELPHIS BOSSI

FOR EXPLANATION OF PLATE SEE PAGE 38

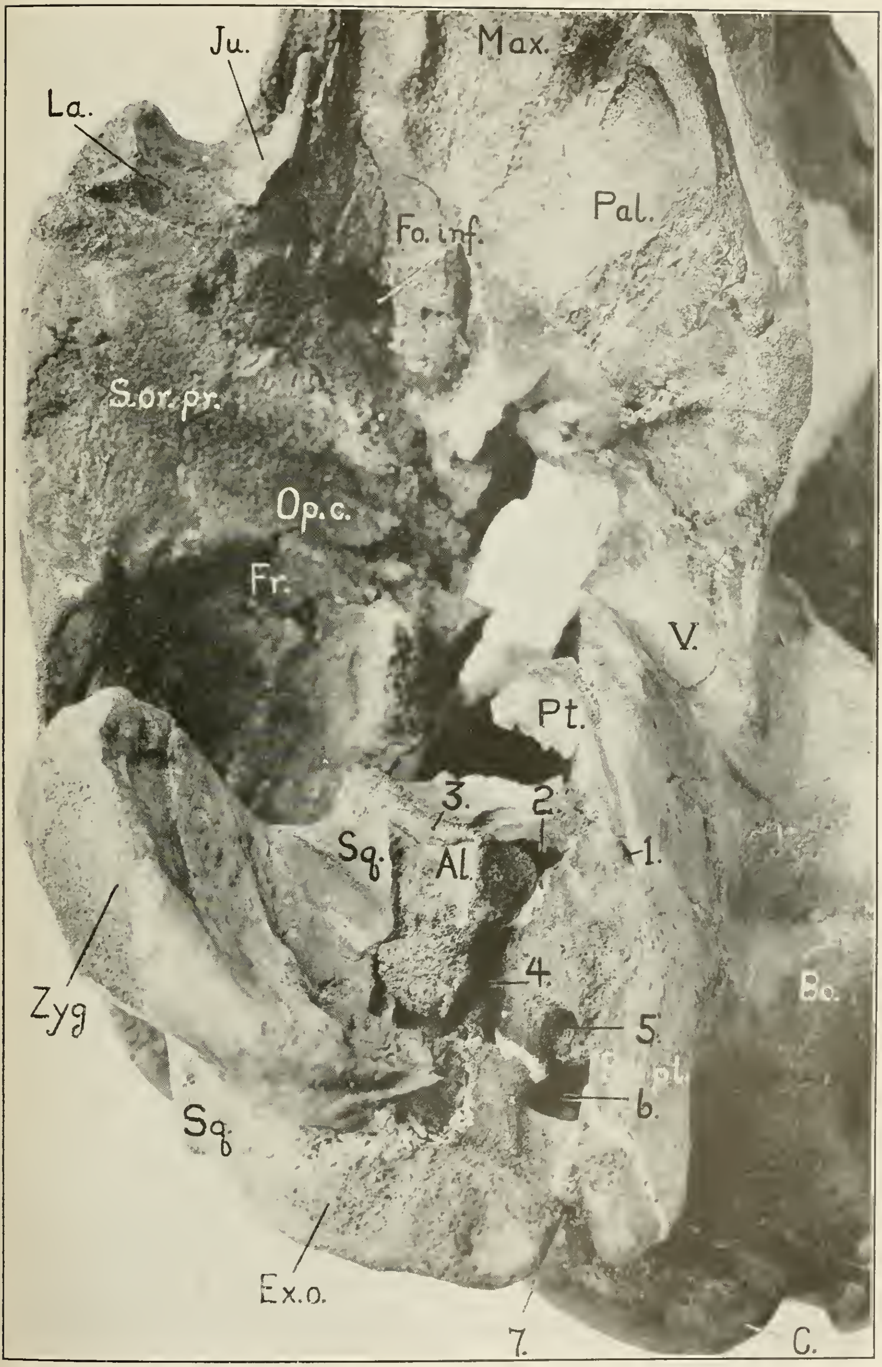


Dorsal View of Type Mandible of Eurhinodelphis bossi

For explanation of plate see page 38

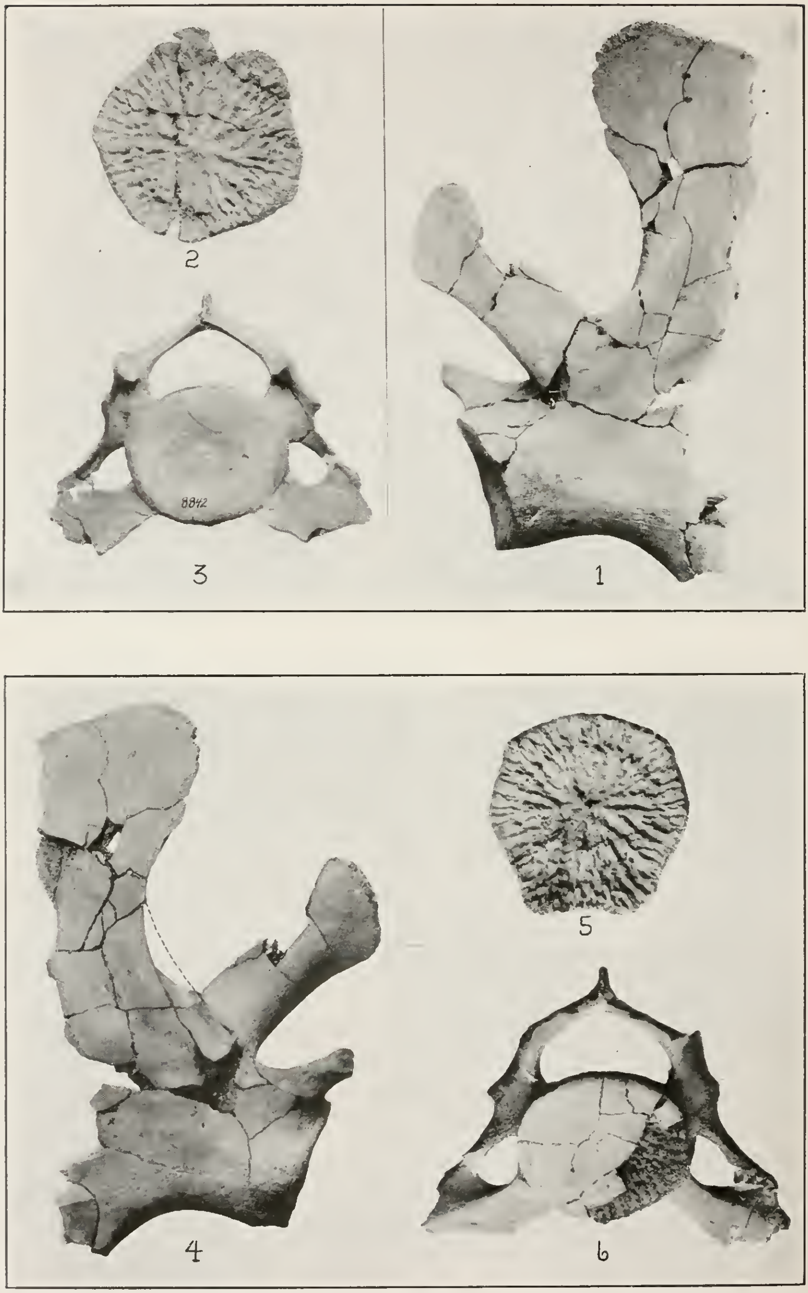
POSTERIOR VIEW OF TYPE SKULL OF EURHINODELPHIS BOSSI

FOR EXPLANATION OF PLATE SEE PAGE 38



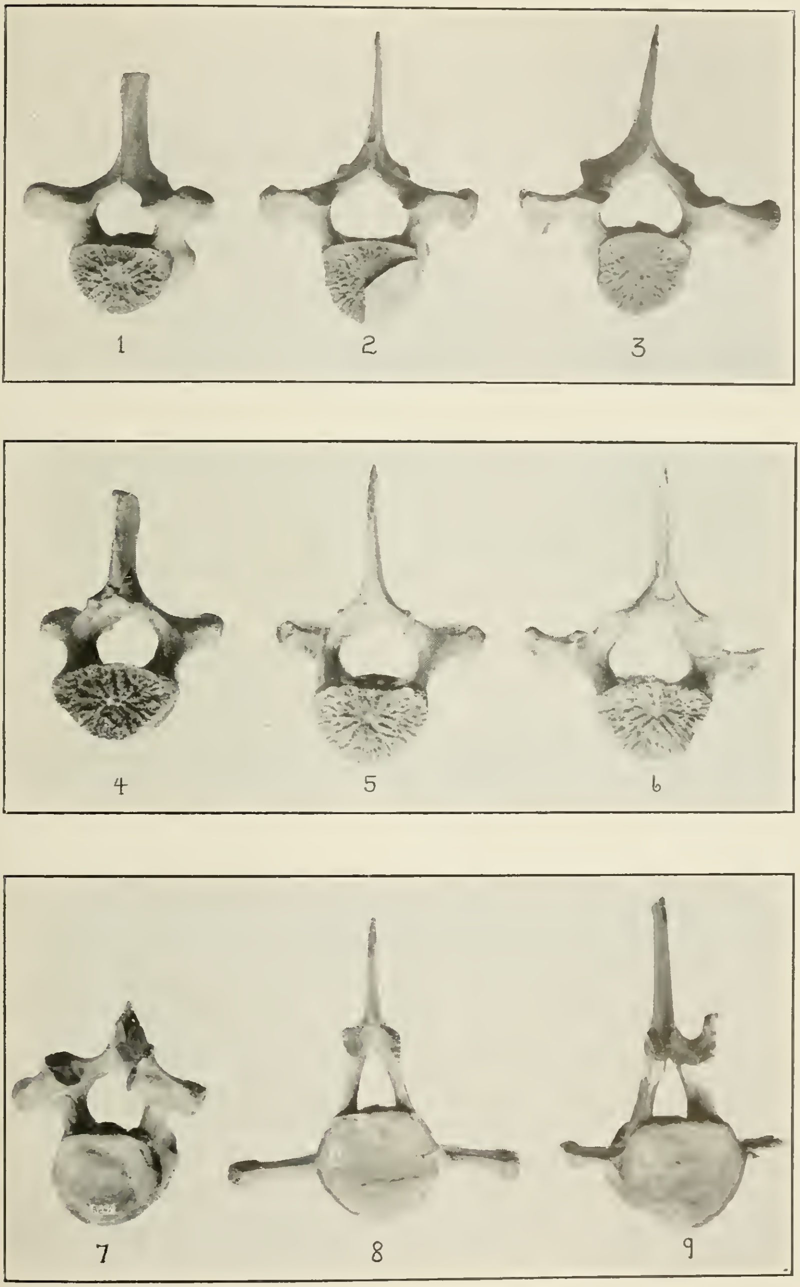
VENTRAL VIEW OF A SKULL OF EURHINODELPHIS BOSSI

FOR EXPLANATION OF PLATE SEE PAGE 38



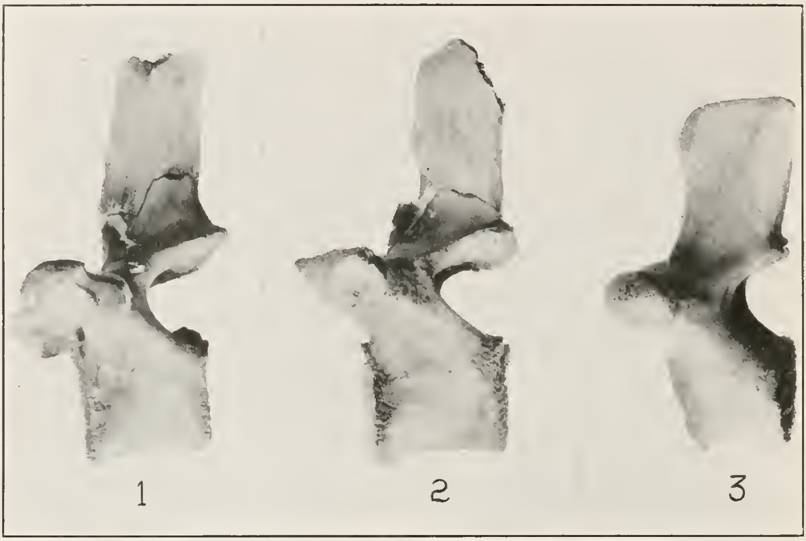
VIEWS OF SCAPULA, CERVICAL, AND EPIPHYSIS OF EURHINODELPHIS BOSSI

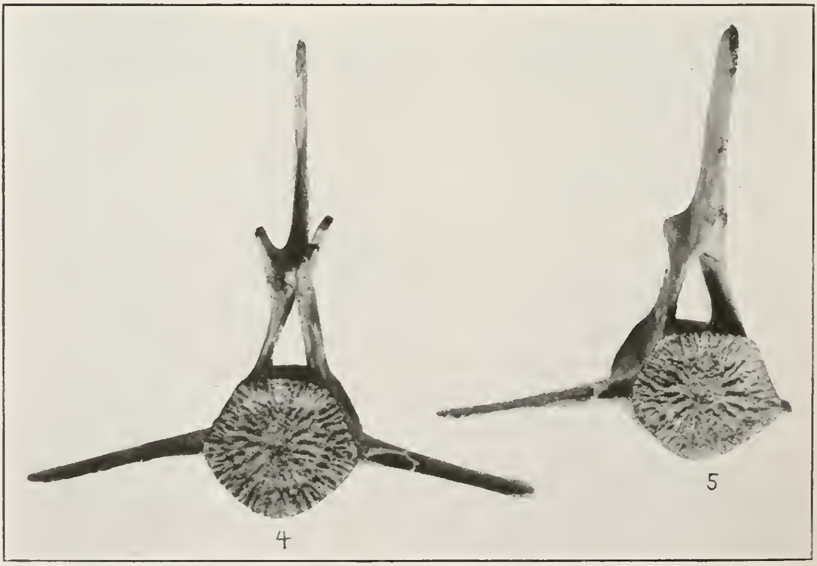
FOR EXPLANATION OF PLATE SEE PAGE 38



VIEWS OF DORSAL VERTEBRAE OF EURHINODELPHIS BOSSI

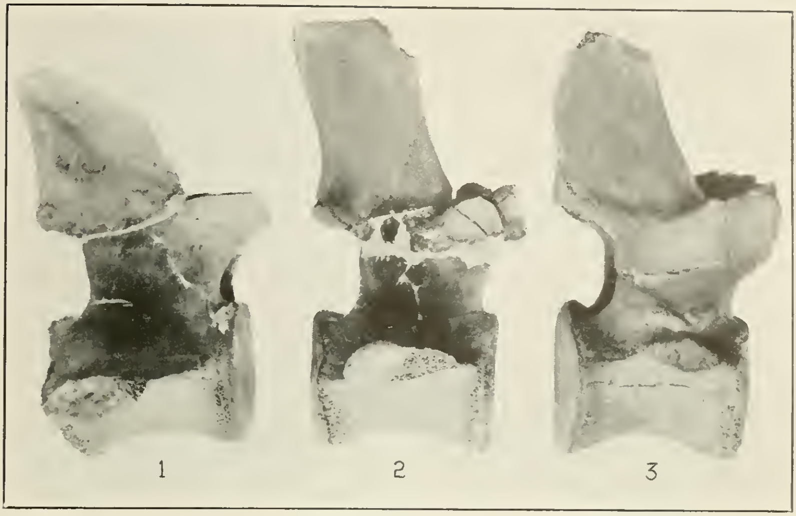
FOR EXPLANATION OF PLATE SEE PAGE 39

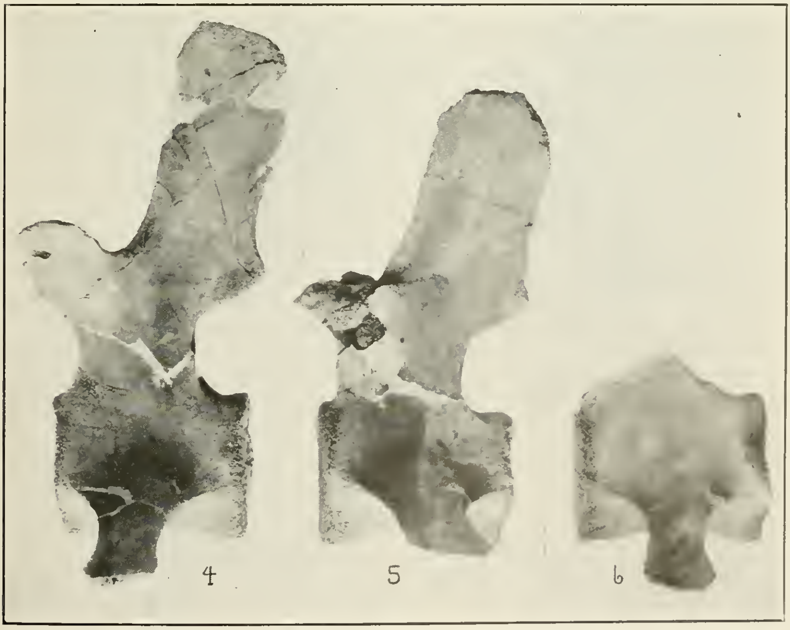




VIEWS OF DORSAL AND LUMBAR VERTEBRAE OF EURHINODELPHIS BOSSI

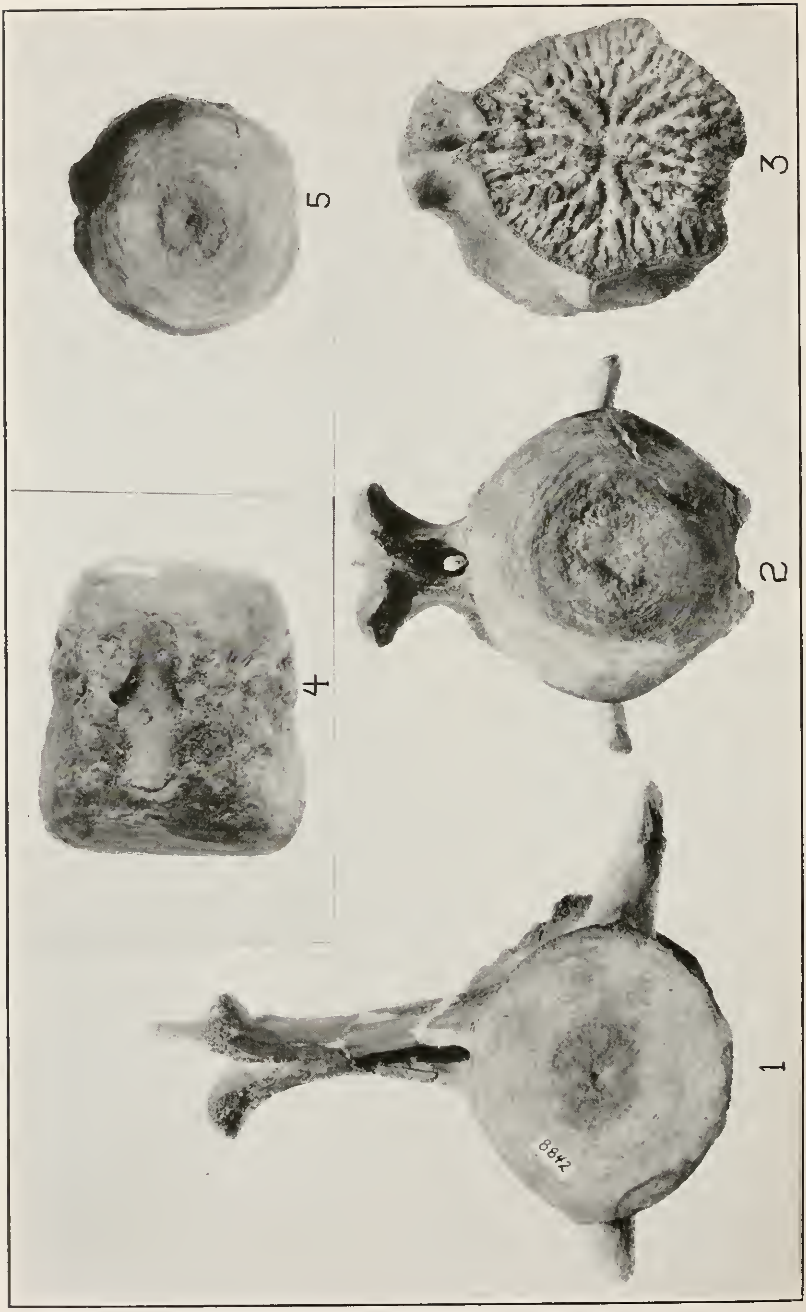
FOR EXPLANATION OF PLATE SEE PAGE 39





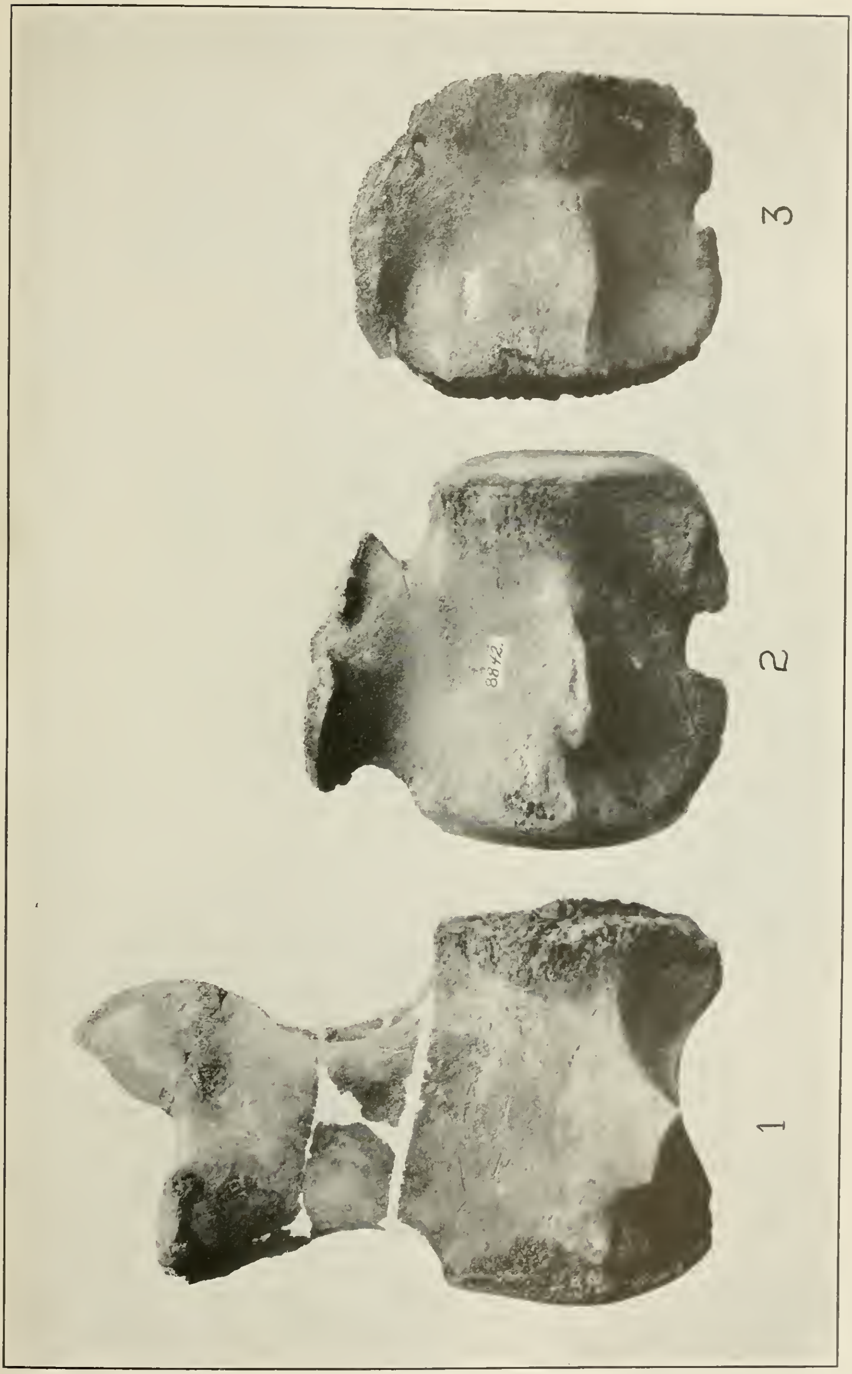
VIEWS OF DORSAL AND LUMBAR VERTEBRAE OF EURHINODELPHIS BOSSI

FOR EXPLANATION OF PLATE SEE PAGE 39



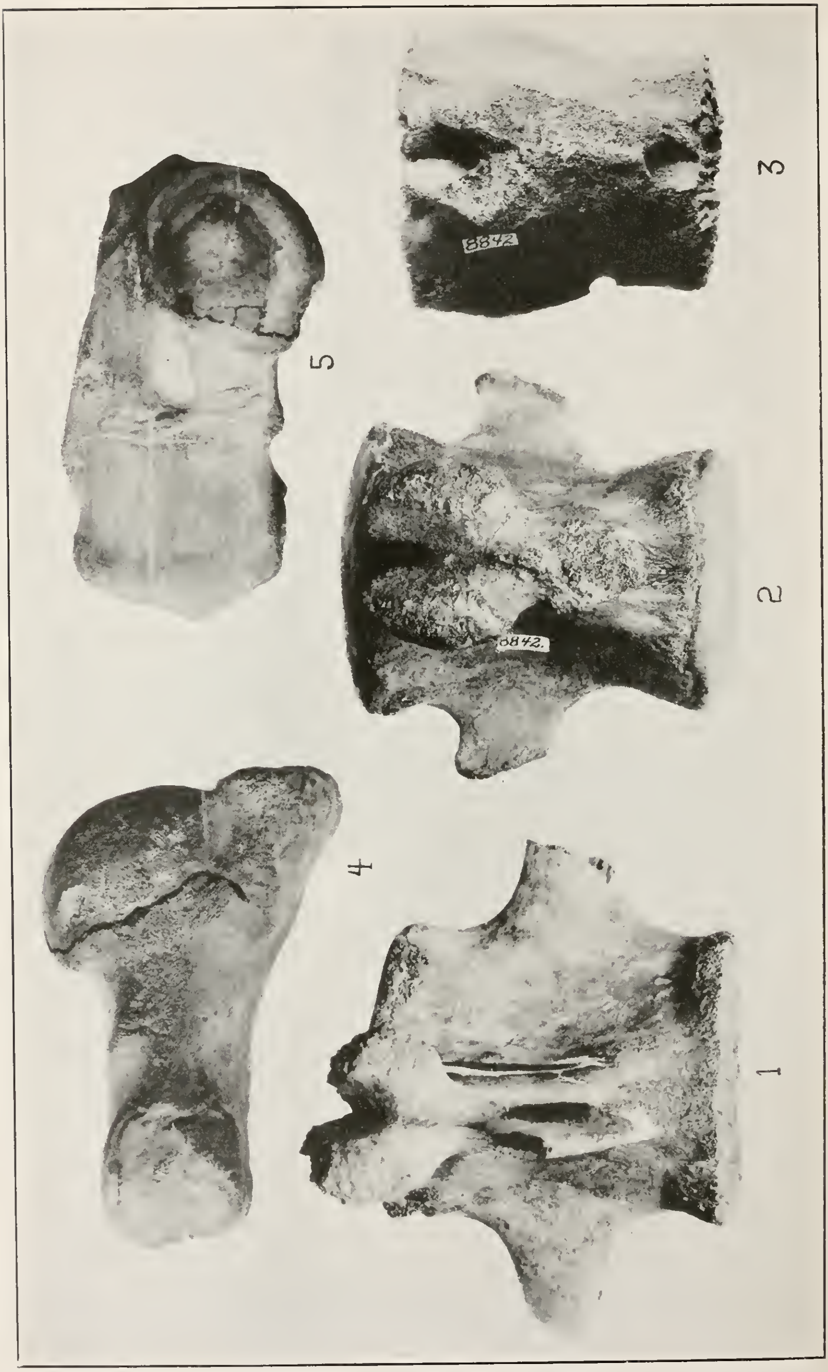
VIEWS OF CAUDAL VERTEBRAE OF EURHINODELPHIS BOSSI

FOR EXPLANATION OF PLATE SEE PAGE 39



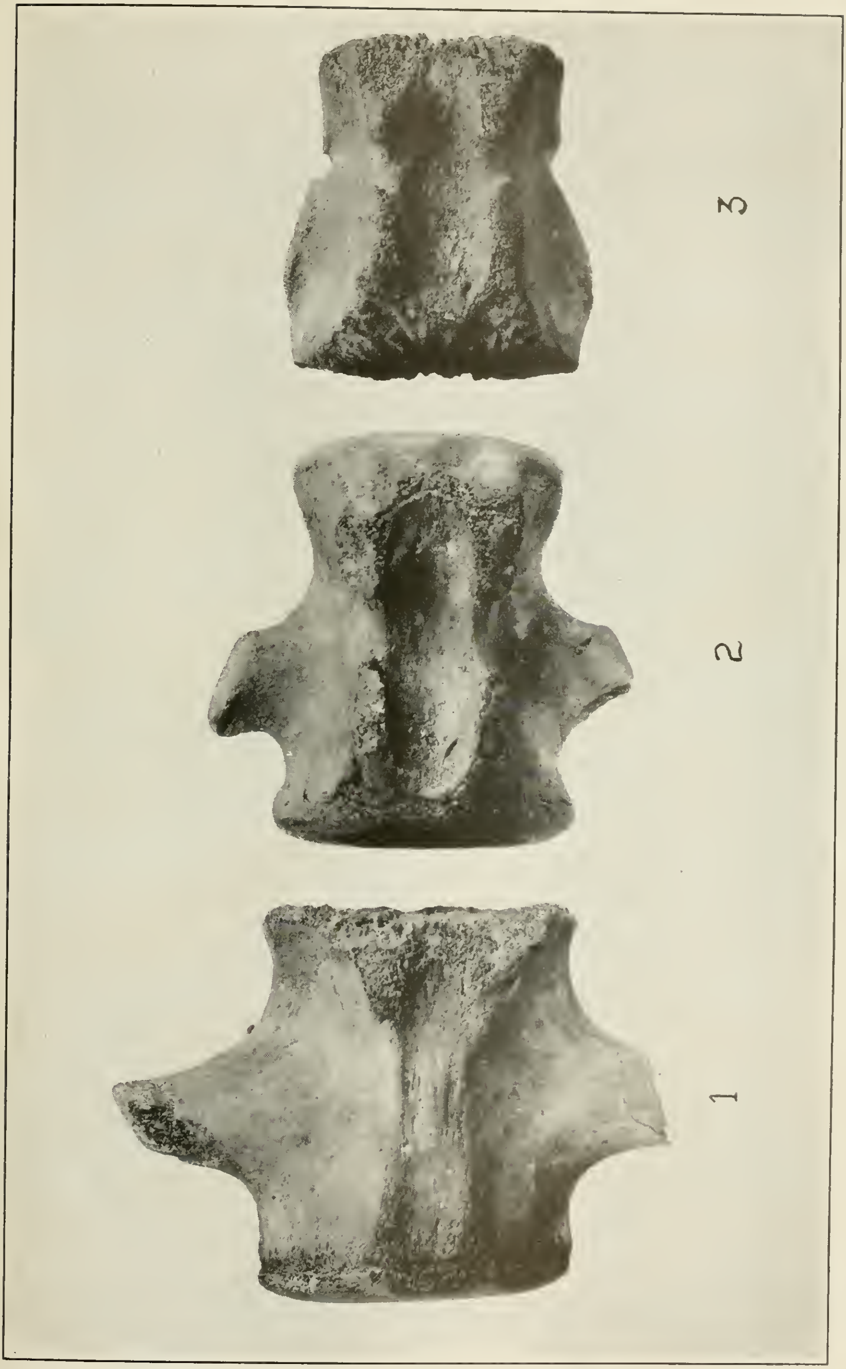
LATERAL VIEWS OF CAUDAL VERTEBRAE OF EURHINODELPHIS BOSSI

FOR EXPLANATION OF PLATE SEE PAGE 39



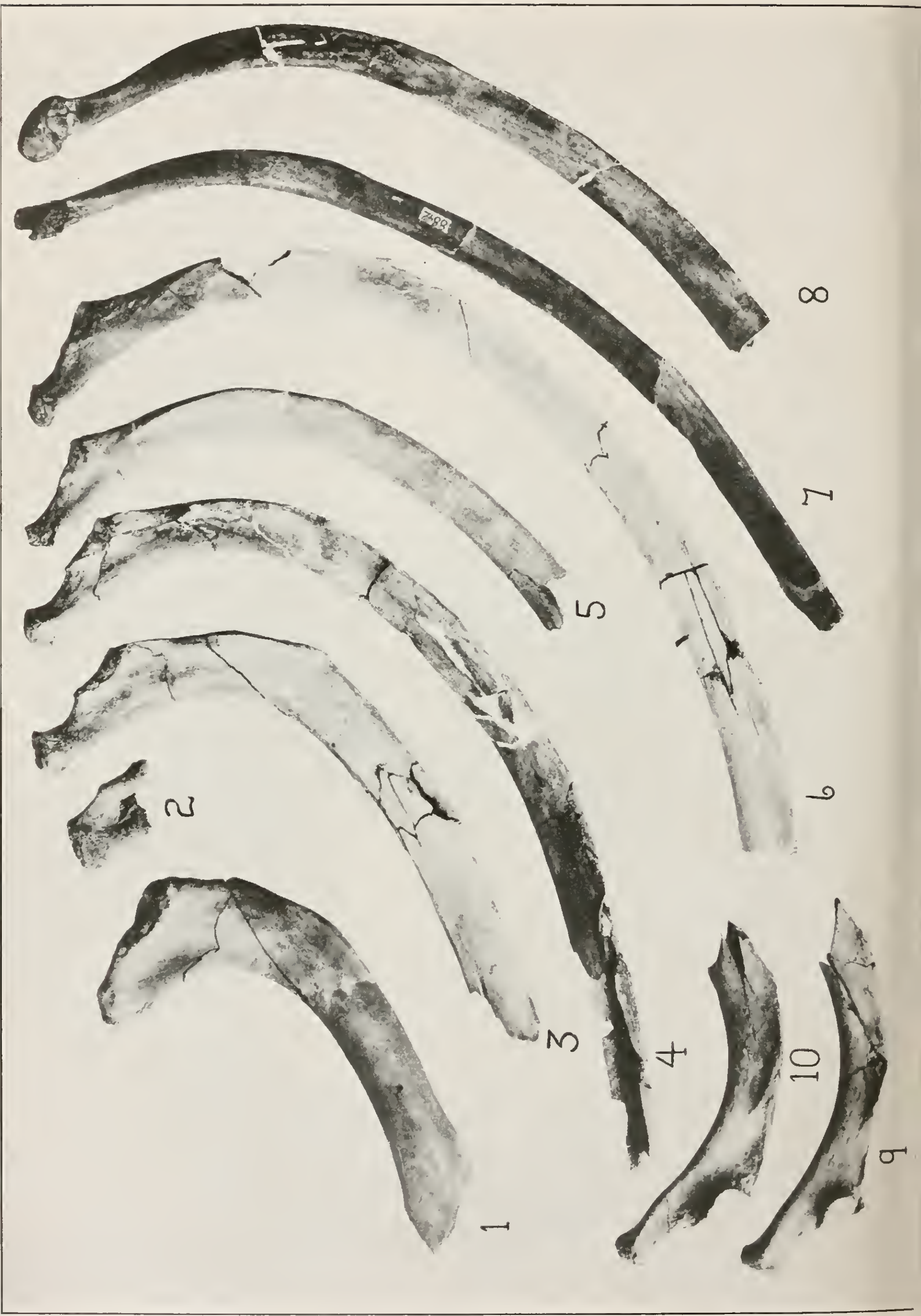
VIEWS OF CAUDAL VERTEBRAE AND HUMERUS OF EURHINODELPHIS BOSSI

FOR EXPLANATION OF PLATE SEE PAGE 39



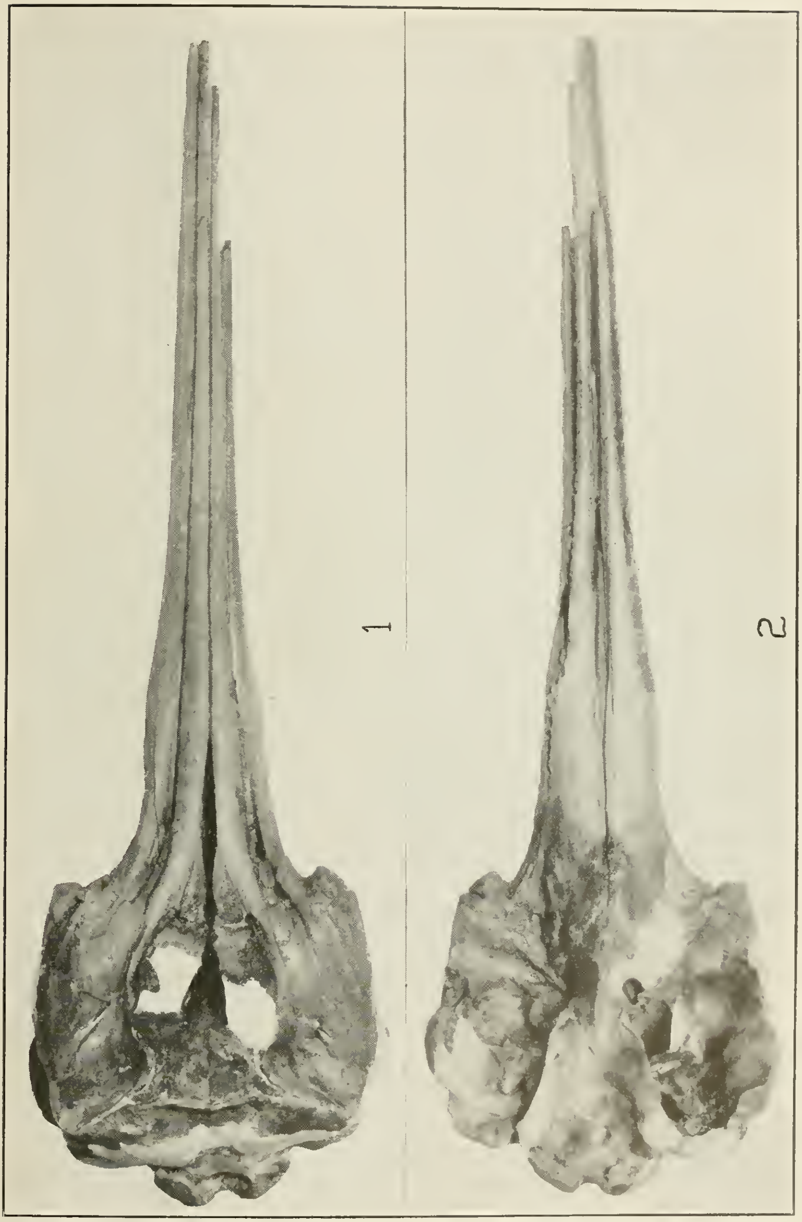
VENTRAL VIEWS OF CAUDAL VERTEBRAE OF EURHINODELPHIS BOSSI

FOR EXPLANATION OF PLATE SEE PAGE 39



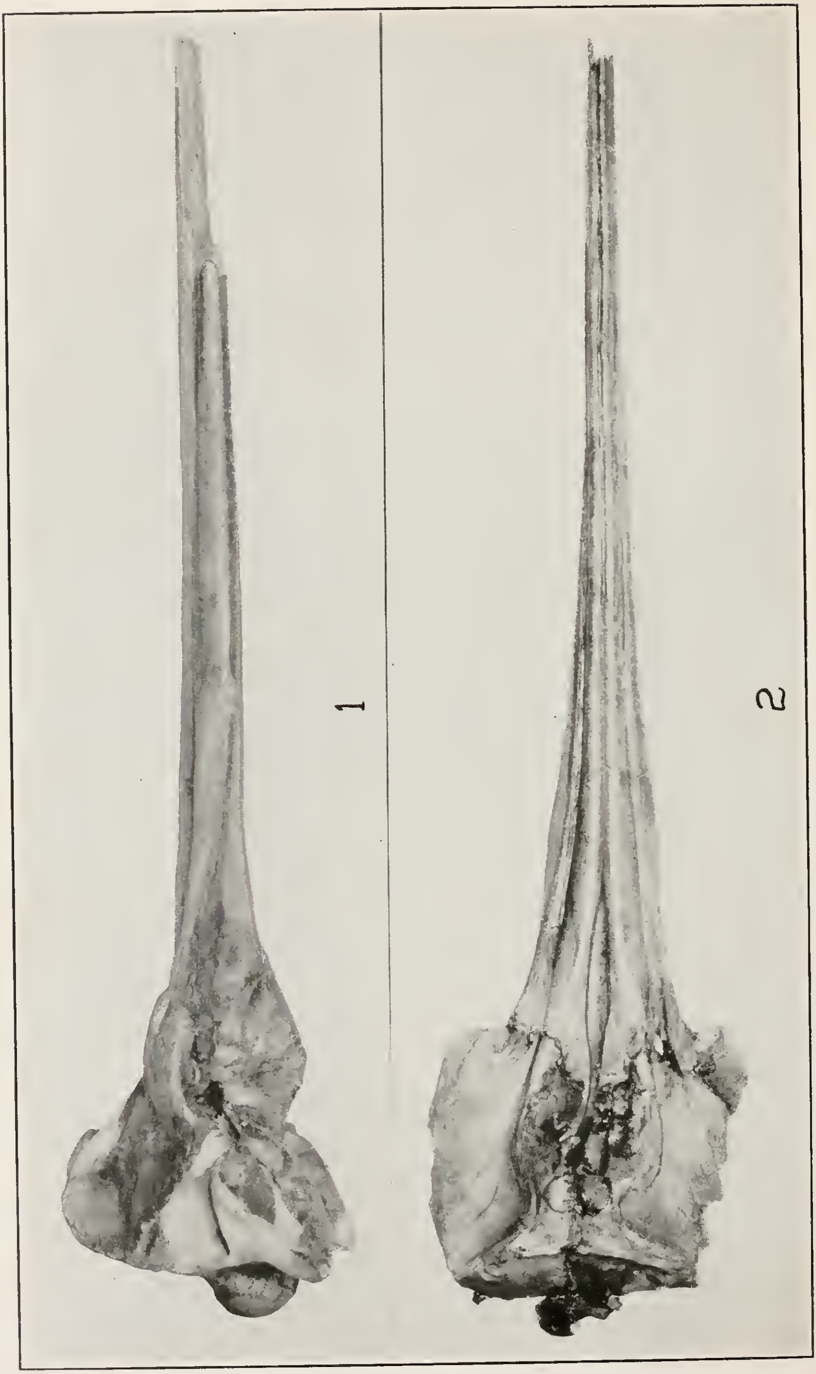
Lateral Views of Ribs of Eurhinodelphis bossi

For explanation of plate see page 39



DORSAL AND VENTRAL VIEWS OF A SKULL OF EURHINODELPHIS BOSSI

FOR EXPLANATION OF PLATE SEE PAGE 40



VIEWS OF TWO SKULLS OF EURHINODELPHIS BOSSI

FOR EXPLANATION OF PLATE SEE PAGE 40

LATERAL VIEW OF A SKULL OF EURHINODELPHIS BOSSI

FOR EXPLANATION OF PLATE SEE PAGE 40

A FOSSIL PHYSETEROID CETACEAN FROM SANTA BARBARA COUNTY, CALIFORNIA

By Remington Kellogg

Of the Bureau of Biological Survey, U. S. Department of Agriculture

The discovery of a skull of a fossil physeteroid whale anywhere is worth recording, and when one is found on the Pacific Coast of North America, the occurrence is all the more important in view of the present inadequate record of their presence there during tertiary times. The living sperm whale is almost cosmopolitan in its distribution, and there is considerable evidence to support the assumption that the geographical range of many, if not all, of the fossil representatives of this family included the Pacific as well as the Atlantic ocean. The suggestion may be offered here that these cetaceans, in particular, will eventually prove to be very useful for purposes of intercontinental geological correlation. Sooner or later, these widely scattered occurrences of fossil sperm whales will assist in either corroborating or modifying some of our concepts as to the age of various marine formations.

Comparative measurements indicate that a complete skull of this species will measure between 4 and 5 meters (12 and 15 feet) in length. If this estimate is correct, then the skull of this species is more than twice as long as that of *Physodon patagonicus* Lydekker from a lower Miocene tuff formation on the coast of Chubut Territory, Patagonia, and probably represents the largest Miocene physeteroid thus far described. This specimen is tentatively referred to the genus *Ontocetus* of Leidy. Although only a small portion of the skull is available for description at present, it obviously represents a distinct type, and requires a name.

Through the interest of Dr. J. P. Harrington of the Bureau of Ethnology, this specimen was presented to the United States National Museum by Mrs. Charles O. Roe, of Santa Barbara, California. I am indebted to Mr. C. W. Gilmore, curator of the Division of Vertebrate Palaeontology, for the opportunity to describe this specimen.

ONTOCETUS OXYMYCTERUS, new species

Type specimen.—Cat. No. 10923, Division of Vertebrate Palaeontology, United States National Museum. The material includes the distal end of the rostrum, the extremities of both mandibles with the roots or portions of 10 or 11 teeth in place, as well as several imperfect teeth which were found in the adjoining matrix.

Type locality.—The occurrence is as follows: Near latitude 34° 20′ 12″ north, and longitude 119° 43′ 20″ west, in the sea cliff which follows the beach north of the Santa Barbara lighthouse, Santa Barbara County, California. Range 27 west, township 4 north, Santa Barbara special map, United States Geological Survey.

Horizon.—The specimen was discovered by Mr. Charles O. Roe some 35 years before he finally removed it to his home in Santa Barbara during the year 1909. The rostrum and mandibles were found projecting from the sea cliff at an elevation of about 12 feet above the high water mark. The sea cliff is nearly 80 feet high at the point where the skull was found, but the writer can not give any estimate as to the thickness of the stratum or as to the relative position of the specimen within it. I am indebted to Mr. Earl V. Shannon, Assistant Curator of Geology, for the following report on the matrix.

The specimen submitted for examination consists of a dense almost aphanitic laminated rock of medium olive buff color. Superficially it resembles a rhyolite with a flow structure more than a sedimentary rock and this resemblance is heightened by scattered nearly spherical cavities a millimeter or two in diameter which, under a binocular microscope, are seen to be lined with minute, sparkling, rhombohedral, colorless, or slightly yellowish crystals. In dilute (1:1) hydrochloric acid the rock effervesces slowly in the manner characteristic of a dolomite and upon warming in the acid large pieces are completely dissolved leaving little residue and with the separation of a considerable amount of oily matter. The solution, after removal of iron, lime, etc., in the usual manner, reacts copiously for magnesia with microcosmic salt. The rock is evidently a fairly pure bituminous dolomite.

No direct reference to the deposits which comprise the sea cliff west of the Santa Barbara lighthouse can be found and Arnold[1] writes that "the structure of the coast west of Punta del Castillo was not studied." This stratum of bituminous dolomite, however, probably represents one of the calcareous deposits which alternated with siliceous deposits to form the thick series known as the lower division of the Monterey formation. In the report by Arnold and Anderson,[2] reference is made to "massive beds of peculiar sand-colored limestone with characteristic lamellar weathering." Again in re-

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[1] Arnold, R., Geology and Oil Resources of the Summerland District, Santa Barbara County, California. Bulletin No. 321, U. S. Geol. Surv., Washington, D. C., p. 38, 1907.

[2] Arnold, R., and Anderson, R., Geology and Oil Resources of the Santa Maria Oil District, Santa Barbara County, California. Bulletin No. 322, U. S. Geol. Surv., Washington, D. C., p. 34, 1907.

ferring to a bituminous limestone [=bituminous dolomite as shown by No. 11 in table of analyses, p. 45] from the Redrock Mountain,[3] northeast of Lompoc, Santa Barbara County, they report as follows: "The last analysis (No. 11) represents limestone typical in lithologic appearance of the limestone of the Monterey." The age of this formation is probably Helvetian or later.

Rostrum.—As the base of the rostrum and the braincase still remain in the sea cliff near Santa Barbara, an exact idea of this physeteroid's relation to previously described skulls can not be given at present. The general outlines of the skull, however, were probably similar to *Scaldicetus.* According to the figures of *Scaldicetus mortezelensis* given by Abel,[4] the extremity of the rostrum of that species is not characterized by a lateral compression. This is the most apparent difference between the rostrum of the Santa Barbara cetacean (pl. 1) and that of *Scaldicetus.* The size of the teeth and the general appearance of their dentinal axes indicate some relationship with *Ontocetus.* All previously described skulls of fossil physeteroids, in so far as can be judged from the imperfectly preserved specimens now known, were characterized in part by the presence of three teeth in the extremity of each premaxilla. In these forms the extremity of the rostrum is formed by the premaxillae alone. In this Santa Barbara skull, also, the premaxillae take part in the formation of the extremity of the rostrum and three of the teeth on each side are implanted in the premaxilla. The lateral compression of the distal portion of the rostrum is quite noticeable in certain genera, particularly so in *Physodon patagonicus* and *Diaphorocetus mediatlanticus.* The extremity of the rostrum of this fossil physeteroid was constricted from side to side and the inner margins of the premaxillae are in contact along the median line as in *Physodon patagonicus*, forming a roof for the mesorostral gutter. On comparing the dorsal view of this Santa Barbara rostrum with that of *Physeter*,[5] other peculiarities become apparent. In the latter, the rostrum is more or less attenuated anteriorly, but the abrupt constriction or lateral compression of the distal portion of the rostrum has disappeared with the horizontal expansion of the rostrum.

While removing the matrix it became evident that this skull had partially decayed before it was completely buried in the sediments which preserved it. Furthermore, some of the teeth were broken off in the alveoli previous to its burial, for on removing the matrix which covered the right mandible, the roots of the teeth were ex-

[3] Arnold, R., and Anderson, R., Geology and Oil Resources of the Summerland District, Santa Barbara County, California.

[4] Abel, O., Mem. Mus. roy. d'hist. nat. de Belgique, Bruxelles, vol. 3, p. 67, fig. 5 1905.

[5] Van Beneden, P. J., and Gervais, P., Ostégraphie des Cetacés vivants et fossiles, Paris, Atlas, pl. 19, figs. 5–6. 1880.

posed to view. Other teeth dropped out of the alveoli in the upper jaws after the skull was covered with sediments as several were found in the matrix. The outer surface of the maxilla is worn, more so in some places than in others. Nevertheless, it appears that the anterior alveoli in the maxilla are separated from the outer surface by a very thin plate, hardly more than 15 mm. in thickness. The lateral border of the maxilla overhangs the alveoli more noticeably posteriorly than anteriorly. The alveoli in the maxillae agree in size with those for the corresponding teeth in the mandibles. At least eight alveoli are present in the distal end of each maxilla and a complete skull may have carried 18 or more teeth in each jaw. From the inferior margin, the maxilla curves upward to the premaxilla in a gradual curve which becomes more pronounced as the maxilla attains a greater depth posteriorly. Apparently, the horizontal plate-like inwardly projecting portions of the premaxillae do not roof the mesorostral gutter to the extremity of the rostrum, but this can not be stated with any degree of certainty for although they taper rapidly their extremities are clearly mutilated. The maxillae gradually increase in breadth toward the base of this section of the rostrum and then appear to suddenly expand as would be expected in a skull characterized by a lateral constriction of the extremity of the rostrum. From a lateral view the maxillae increase in depth as they approach the base; whereas the premaxillae decrease.

The mesorostral gutter extends the full length of the rostrum. Its distal extension is made up entirely by the premaxillae which meet mesially on the floor in a linear suture. Posterior to the third pair of alveoli is the distal extremity of the vomer which contributes the floor of the gutter for most of its length, and on each side is mortised into the ventral extensions of the premaxillae and they in turn are applied to the inner borders of the maxillae. From its extremity posteriorly, the vomer increases in width and eventually gains a position on the walls. The dorsal wall or roof of the vomerine gutter is formed, as mentioned above, by the overhanging plate-like portions of the premaxillae. From the level of the third pair of alveoli posteriorly, the premaxillae retain a nearly uniform breadth.

Mandibles.—Since this specimen projected from the face of the cliff and was exposed to the action of the elements for 35 years at least, it is not surprising that the inferior surfaces of the mandibles should exhibit evidence of considerable erosion. From a ventral view, numerous branching canals are now visible, although they are filled with matrix, which afforded passage for nerves and blood vessels. In places, this wear has amounted to an inch or more in thickness.

The extremities of the mandibles are relatively large in comparison to the rostrum and in general conformation are somewhat similar to those of *Physeter*. Pressure or other factors resulted in the separation of the mandibles at the symphysis. The left mandible does not lie in its normal position and its inner face is appressed against the ventral surface of the rostrum. The proximal portions of the mandibles were not collected and as the inner faces of these mandibles begin to diverge some 170 mm. in front of the point where they were broken off, it is evident that all of the symphysial region is represented. If this is the case then the symphysis of the mandible is coextensive with the first eight pairs of teeth. Both mandibles curved upward from the posterior end of the symphysis forward. The distal extremity of each mandible is obliquely truncated in a dorso-ventral direction while the external and internal faces of the mandible descend abruptly from the dorsal surface which is relatively flat.

The tooth-bearing portion of the mandible is relatively massive and the bone itself is rather dense. The alveoli (pl. 2) are large and the posterior ones occupy more than half of the width of the mandible. In this fossil, the series of teeth in each mandible consists of more than eleven slightly curved and conical teeth. The first and third teeth are the smallest of the mandibular series. The roots of all the teeth available for examination from the upper jaw are terminated obtusely and no doubt those of the mandible are similar in appearance. Two teeth, the inner one much smaller than all of the following with the exception of the third, project obliquely forward from the extremity of each mandible.

Teeth.—Turning to the teeth, we find that they are all very large and that some of them may have projected 4 or 5 inches beyond the jaws. They are separated by intervals or septa narrower than the thickness of the cement. In respect to their mode of implantation in the jaw, the teeth differ from those of *Physeter* in that they are lodged in distinct alveoli and the septa extend the full depth of the alveolus. These alveoli are too large to hold the teeth in place independently of a dense ligamentous gum which accounts for their absence from the alveoli in the upper jaw. The position of the mandibles prevented the teeth from falling out of the alveoli and in some instances the matrix in the alveolus which encircles the root attains a width of 20 mm. or more. This interval affords another indication of how loosely the teeth were implanted in the jaws. All the crowns of the teeth, with the exception of the third in the right mandible, either were broken off at the time the specimen was removed from the sea cliff or were destroyed before burial. The summit of the crown of this tooth is abraded and the enamel is ornamented with coarse longitudinal striae.

The crown of the third mandibular tooth is broken off obliquely in an interno-external direction. The enamel forms a band encircling the crown of the tooth, about 1 mm. in thickness and approximately 35 mm. in depth when complete. The crown and upper part of a tooth which broke away from the end of the root in the mandible at the time the specimen was removed from the sea cliff measures 153 mm. in length. The greatest transverse diameter of the base of this apical section of the tooth equals 68 mm. and the maximum thickness of the cement is 9.5 mm. At the level of the superior face of the mandible, the outer coat of cement varies from 10 to 19 mm. in thickness. From these measurements it is evident that a short section of the root which intervenes between this apical portion and the distal extremity is missing. A large mandibular tooth will measure at least 300 mm. in length. The roots of these teeth are fusiform, remarkably robust, and very large in proportion to the crown. They are almost straight at the basal two-thirds, but curved toward the crown so that the latter appears to be obliquely placed upon it.

The enamel on the crown does not form an enlargement at the base and passes into the cement on the root without any perceptible increase or decrease in the diameter of the neck. Hence there is no distinct neck and no constriction at this point can be observed on any of the teeth which are sufficiently preserved to offer any data. The distal extremities of all the teeth are present in the left mandible. At their upper ends, a small pulp cavity is exposed in the second and ninth teeth, measuring 3.5 and 7.5 mm. respectively in diameter. This indicates that the lower portions of the roots were pervaded by a slender pulp cavity, irregular in diameter because of the presence of nodosities on the sides.

As seen in cross section, the teeth consist of an internal cone of ossified pulp and dentine which is covered externally by a thick layer of cement. This outer coat of cement is usually brownish in contrast to the light cream-colored dentine, and on the eighth tooth of the right mandible is equal to about one-fourth of the transverse diameter of the root. The dentinal axis is formed in concentric layers while the cement on the other hand appears to be composed of thin and narrow longitudinal strips or laminae. In cross section, the ends of these laminae are so arranged that their axes correspond to lines radiating from the center of the pulp cavity.

The most obvious distinction between these teeth and that of *Ontocetus emmonsi* is the relative thickness of the outer layer of cement. In cross section the central axis of dentine appears to be more or less ovoidal in the anterior mandibular teeth in contrast to the circular outlines of the posterior ones, but this may be due in

part to differences in the direction of the teeth in the alveoli, the former being implanted more obliquely than the latter. Thin ridges which encircle the dentinal axis and which have been referred to as annular lines of growth are present. Longitudinal grooves or fluting, varying in number and in depth among the several teeth at hand, further characterize the external surface of the dentinal axis. The teeth of *Scaldicetus caretti*, a physeteroid whale from the Anversian of Belgium, agree with those of this Californian species in size.

All of the teeth are imperfectly fossilized and the dentine especially is rather soft and pithy. In their present state, difficulties which are familiar to anyone who has attempted to preserve tusks of mastodons, are encountered when the teeth are freed from the matrix. The teeth fracture and crumble even when every precaution is taken for their preservation.

Measurements of the rostrum and mandibles

	mm.
Total length of rostral fragment along the median line	845
Width of right premaxilla at proximal end of rostral fragment	97
Width of right premaxilla at level of second alveolus	91
Depth of right premaxilla at proximal end of rostral fragment	190
Depth of right premaxilla above maxillary suture at level of fifth alveolus	69
Breadth of rostral fragment at proximal end (left maxillary surface worn off)	405
Breadth of rostral fragment at point 100 mm. posterior to distal end	170
Breadth across combined premaxillae at proximal end of rostral fragment	213
Breadth across combined premaxillae at level of fifth alveolus	211
Total length of fragment of right mandible	965
Depth of right mandible at proximal end	192
Depth of right mandible at extremity	117
Breadth of right mandible at proximal end	175
Breadth of right mandible at extremity	123
Total length of fragment of left mandible	920
Depth of left mandible at proximal end	196
Depth of left mandible at extremity	115
Breadth of left mandible at proximal end	180
Breadth of left mandible at extremity	117
Greatest transverse diameter of root of first tooth, left mandible	54
Greatest transverse diameter of root of second tooth, left mandible	74
Greatest transverse diameter of root of third tooth, left mandible	70
Greatest transverse diameter of root of fourth tooth, left mandible	66.5
Greatest transverse diameter of root of fifth tooth, left mandible	67.5
Greatest transverse diameter of root of sixth tooth, left mandible	70
Greatest transverse diameter of root of seventh tooth, left mandible	78.5
Greatest transverse diameter of root of eighth tooth, left mandible	89
Greatest transverse diameter of root of ninth tooth, left mandible	90.5
Greatest transverse diameter of root of tenth tooth, left mandible	71
Length of enamel crown of third tooth, right mandible (apex missing or worn off)	30+

	mm.
Greatest antero-posterior diameter of enamel crown of third tooth at base, right mandible	32
Eighth tooth, right mandible:	
Transverse diameter of tooth at level superior face mandible	82
Transverse diameter of dentinal axis	50
Greatest width of cement in same place	18
Pulp cavity closed.	
Eighth tooth, left mandible:	
Transverse diameter of tooth at level superior face of mandible	93
Transverse diameter of dentinal axis	62
Greatest width of cement in same plane	19
Pulp cavity closed.	
Ninth tooth, right mandible:	
Transverse diameter of tooth at level of superior face of mandible	80
Transverse diameter of dentinal axis	46.3
Greatest width of cement in same plane	19
Transverse diameter of pulp cavity at same plane	7.5

EXPLANATION OF PLATES

Plate 1

Dorsal view of type rostrum and mandibles of *Ontocetus oxymycterus*

The internal face of the left mandible is covered with the matrix.

Abbreviations: *Max*, maxilla; *Pmx*. premaxilla.

Plate 2

Lateral view of type rostrum and dorsal view of right mandible of *Ontocetus oxymycterus*

This view shows that the extremity of rostrum is formed by the premaxillae; the end of the maxilla, which normally forms the external wall of the fourth alveolus, is missing.

Abbreviations: *Max*. maxilla; *Pmx*. premaxilla.

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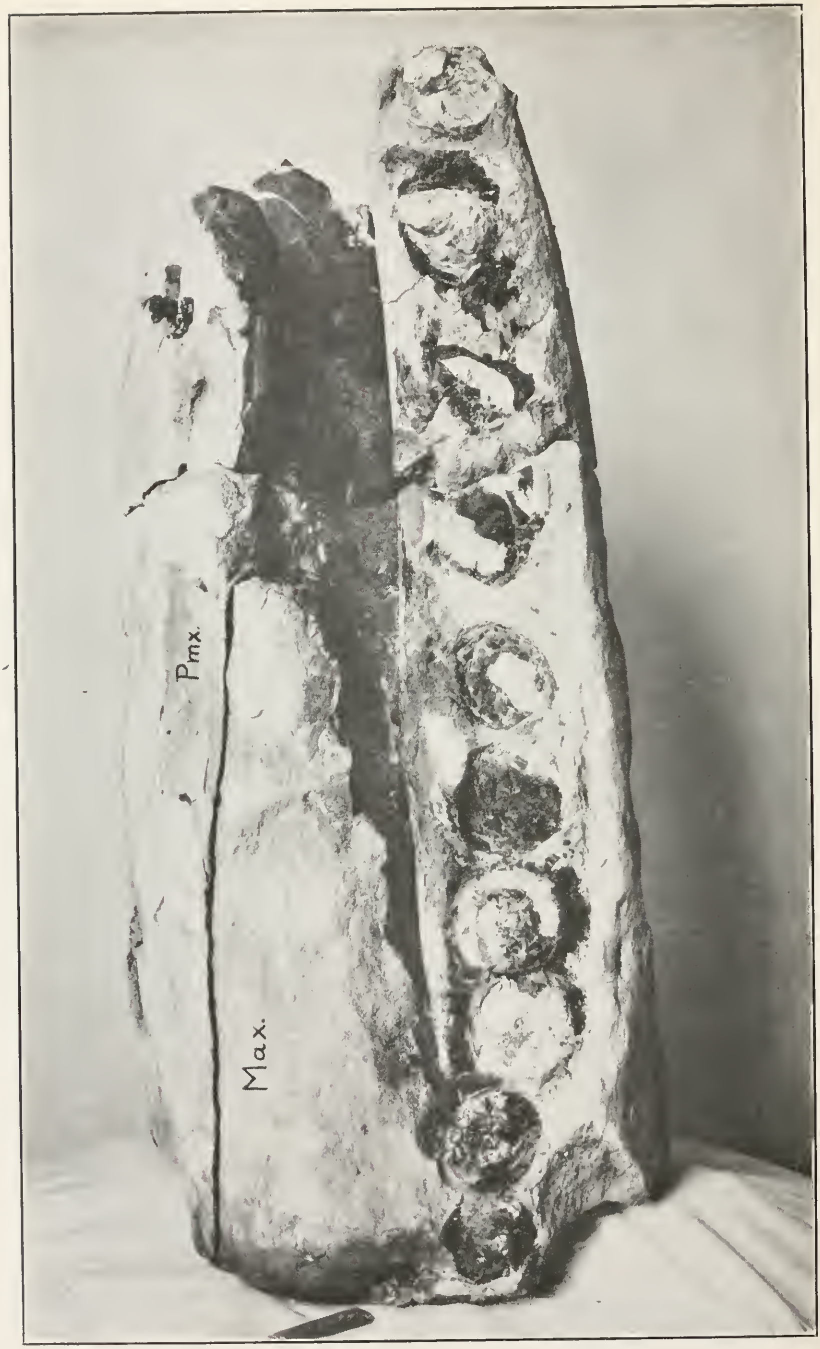
VIEWS OF ROSTRUM AND MANDIBLES OF ONTOCETUS OXYMYCTERUS

FOR EXPLANATION OF PLATE SEE PAGE 8



VIEWS OF ROSTRUM AND RIGHT MANDIBLE OF ONTOCETUS OXYMYCTERUS

FOR EXPLANATION OF PLATE SEE PAGE 8

MINERALOGY AND PETROGRAPHY OF TRIASSIC LIMESTONE CONGLOMERATE METAMORPHOSED BY INTRUSIVE DIABASE AT LEESBURG, VIRGINIA

By Earl V. Shannon

Assistant Curator of Geology, United States National Museum

INTRODUCTION

The present article is intended to follow a preceding much lengthier paper on Triassic diabase at Goose Creek, Virginia.[1] In that paper the diabase, which forms an intrusive sill-like mass several hundred meters in thickness, is described in detail, and it was concluded that certain secondary minerals, among them datolite, prehnite, apophyllite, and certain zeolites, were deposited by magmatic waters expelled by the diabase magma at the end of its consolidation. Various hydrothermal effects of the magmatic solutions upon the consolidated diabase were also considered. The following description considers the case where these magmatic solutions, emanating from the crystallizing diabase, ascended along fissures in the overlying limestone and the alteration of the limestone and the secondary minerals deposited, both as fillings of open cavities and by metasomatic replacement of the limestone itself, are described in detail.

The quarry was visited at various times with several other mineralogists, namely, Frank L. Hess, Esper S. Larsen, Clarence S. Ross, Waldemar T. Schaller, and Ralph W. G. Wyckoff, to all of whom I am deeply indebted for valuable assistance and advice.[2] I would especially express my thanks to Doctor Ross for help and

[1] Earl V. Shannon. Mineralogy and Petrography of intrusive Triassic diabase at Goose Creek, Loudoun County, Virginia. Proc. U. S. National Museum, vol. 66, pp. 1–86, 1924.

[2] Since this paper was written and following the December, 1923, meeting of the Geological Society of America and the Mineralogical Society of America in Washington, a field trip was held to this locality under direction of the writer, which was attended by numerous other scientists of national and international repute.

opinions throughout the preparation of the paper and to Dr. Edgar T. Wherry for kindly reviewing the manuscript and offering numerous helpful criticisms.

LOCALITY

The locality described is a quarry at the north side of the Washington & Old Dominion Electric Railway a short distance east of Leesburg station. The main pit now being worked is about 80 meters long by 30 meters wide and about 30 meters deep. The rock is the limestone conglomerate, known as Potomac marble, which frequently occurs at the western border of the Triassic area, and consists of limestone fragments in a calcareous matrix, the product being used as lime, mainly for agricultural purposes. The location is about three miles northwest of the previously described Goose Creek diabase quarry and is immediately above the roof of the same intrusive diabase sill.

GENERAL RELATIONS

The bottom of the quarry is believed to be, at most, only a few meters from the roof of the large sill, the contact of which is reported to have been encountered in an adjoining quarry which is now filled with water. Near the bottom of the east wall of the pit two dikes of basalt are exposed, which are doubtless apophyses of the main igneous mass. The exact relations of the dikes are not clear mainly because of a fault which is exposed here and which has greatly fractured the limestone, locally largely replaced by diopside, but they seem to dip at a low angle to the east toward the sill, the roof of which apparently dips west. The rock quarried from the eastern side of the quarry is much harder than the rest, owing to being higher in silica, and is used mainly for road "metal." The exact attitude of the faulting likewise could not be made out but both the basalt and the silicated limestone have been involved in crushing movements. The large amount of diopsidation of the limestone adjacent to the dikes is probably not due to the fact that the dikes are intruded here but rather to the fact that the fissures along which the dikes were intruded have been reopened giving a channel which carried the heated solutions emanating from the sill. Although the attitudes of the large masses of diopside and diopside garnet rock are not clear, the manner of their formation is indicated by certain smaller altered zones along smaller fractures where the replacement of the limestone can be studied in detail. Some of these are well exposed in the north wall of the quarry, and a typical cross section of one of them, illustrated in plate 1, shows the principal features of the replacement. These are re-

garded as having originated by the hydrothermal replacement of the limestone and some of them are persistent to a considerable distance from the diabase mass. The minerals thus developed in the limestone are those typical of what are commonly called contact metamorphic deposits in limestone. Inasmuch as the replacement is clearly a result of the action of heated solutions, or possibly aqueous vapors, on the walls of the fissure, the conception of contact metamorphism is not greatly emphasized here, the minerals being described instead as high temperature hydrothermal replacements. The minerals occurring in this manner include diopside, garnet, magnetite, serpentine, wollastonite, xonotlite, and probably thaumasite. The other class of secondary minerals, regarded as probably having originated at a somewhat later period marked by a considerably lower temperature, occurs as crystals and fillings of cracks and open spaces along slight fissures in limestone. The limestone of the walls of these fissures is not greatly altered. Deposits of this class include datolite, calcite, diopside, apophyllite, and barite; probably anhydrite was also among these.

THE LIMESTONE CONGLOMERATE

Little that is original can be added regarding the limestone which is quarried. It is Triassic limestone conglomerate which is commonly known as "Potomac marble" and is made up of fragments of limestone of various sizes and colors in a matrix of calcareous sand, the average tone of the rock as a whole being light gray to almost white. Considering its heterogeneous origin the conglomerate is unusually low in quartz and other impurities. Keith [3] gives the following description of the formation:

> The limestone conglomerate is made up of worn pebbles of limestone of various colors, usually blue, interbedded in a reddish calcareous matrix. Rarely pebbles of slate and gray sandstone also occur with those of limestone. The pebbles were deposited in their matrix in a very irregular manner and in sharply limited areas. The areas of conglomerate point off into the sandstone like wedges, their form being due either to thinning out away from shore or to subsequent cutting off by faults. From these masses of limestone pebbles it is inferred that a large body of limestone was exposed to erosion and that from its fragments were produced the worn pebbles. The conglomerate being coarse, it was probably laid down by strong currents or waves along a shore, and is therefore apparently a beach deposit.

Doctor Merrill gives the following account of the formation: [4]

> The only true conglomerate or breccia marble that has ever been utilized to any extent in the United States is found near Point of Rocks, Frederick County,

[3] Arthur Keith. Geol. Atlas U. S., U. S. Geol. Survey, Harpers Ferry Folio. Folio 10, p. 3, 1894.

[4] George P. Merrill. Stones for Building and Decoration. New York, 1891, pp. 92–93.

in this State (Maryland). The rock, which belongs geologically to the Triassic formations, is composed of rounded and angular fragments of all sizes, up to several inches in diameter, of quartz and magnesian limestone imbedded in a fine gray calcareous groundmass. This composition renders the proper dressing of the stone a matter of some difficulty, since the hard quartz pebbles break away from the softer parts in which they lie, leaving numerous cavities to be filled with colored wax or shellac. It should therefore never be worked with hammer and chisel, but only with saw and grinding material, and no attempt made at other than plain surfaces. The stone was used for the pillars of the old Hall of Representatives in the Capitol at Washington, and a polished slab 34 inches long by 20 inches wide may be seen in the National Museum at Washington. The pebbles forming the stone are of so varied shades that to state its exact color is a matter of difficulty. Red, white, and slate-gray are perhaps the prevailing tints. On account of its locality the stone has been popularly called "Potomac" marble, or sometimes calico marble, in reference to its structure and spotted appearance. The formation from whence it is derived is said to commence near the mouth of the Monocacy River, and to extend along the Potomac to Point of Rocks and along the valley on the eastern side of the Catoctin Mountain to within 2 miles of Frederick. The writer is informed, moreover, that the same formation occurs in Virginia, near Leesburg, and that here the quartzose pebbles are almost entirely lacking, thereby rendering the stone less difficult to work.

At the Leesburg quarry the rock consists of pebbles of white, slaty blue or buff fine to coarse-grained marble in a light colored calcareous matrix, so that the general tone of the rock is light colored with no red tints. No quartzose or siliceous pebbles are to be seen and, where the silica content increases it is apparently due to secondary introduction of diopside and other silicates.

THE BASALT

The basalt is exposed on the east side near the bottom of the quarry where it occurs apparently as two flat easterly dipping dikes about a meter in thickness, separated by several meters of diopside rock. The dike rock apparently has been shattered in part by later faulting which took place at various times and some of the basalt was probably broken up and dragged as fragments into the sheared material, subsequent to its consolidation yet previous to the alteration of the limestone to diopside rock.

In the hand specimen the rock is medium dark purplish gray in color and dense in structure, no individual minerals being distinguishable under a lens. It is practically lusterless in the crystalline portion but varies to waxy-lustered in the glassy chilled border phases. The dikes are so jointed that it is difficult to secure a piece large enough to trim into a hand specimen.

Under the microscope the average rock from the dikes is a very fine grained holocrystalline aggregate of feldspar and pyroxene, both of which tend to assume euhedral form, the pyroxene in short

prisms and the feldspar in elongated laths. The rock is all more or less affected by alteration and the feldspars are so sericitized that their determination is impossible. The lath-like habit of the feldspars gives the rock an ophitic appearance but the crystallization of the pyroxene and feldspar was apparently nearly simultaneous. Irregular or rounded rather large dark spots in the section are apparently aggregates of very minute grains of magnetite, dense in the center and thinning toward the borders of the spot. Where small unsericitized remnants of the feldspar remain they have a refractive index distinctly above that of Canada balsam showing that they have not been albitized. In addition to the fine crystalline fabric which forms the body of the rock, there are visible in thin sections certain scattered areas, much larger than the average grain of the rock, which are now green serpentine clearly secondary after original olivine. Occasionally they inclose a core of unaltered olivine. These olivine pseudomorphs seldom show complete crystal outline but have the appearance of fragments of broken up larger crystals. Colorless and fresh pyroxene also occurs rarely like the olivine as larger isolated crystals or groups of several crystals. The freshest rock is cut by very thin cracks filled with fibrous, colorless serpentine.

At the borders of the dikes there are chilled glassy phases which have the same purplish color as the body of the rock except where hydrothermally altered to a dull green. The glassy material has a waxy luster and faintly conchoidal fracture. It is clear isotropic glass of dark brown color in thin section and, like the crystalline rock, contains scattered talc and serpentine pseudomorphs after olivine and a few pyroxenes. The isotropic glass grades into birefracting material and at a distance of 16 millimeters from the contact in one specimen, had graded into wholly birefracting very fine grained material having a fibrous structure suggesting the structure of the crystallized basalt.

HYDROTHERMAL ALTERATION OF THE BASALT

The alteration of the limestone, which, in the vicinity of the basalt dikes is largely converted to lime-silicate rock, by the action of thermal solutions is believed in great part to be subsequent to the intrusion of the basalt. The solutions might naturally be expected to exert some profound influence on the shattered basalt while producing such drastic changes in the limestone but such is not the case. All of the feldspar of the basalt is sericitized, and, as has been mentioned, it is extensively traversed by narrow seams of serpentine. Moreover, there occur, here and there, scattered in the diopsidized limestone, small masses and fragments of more or less glassy basalt from the dikes. These have lost their original purple color and are

now dull olive green. The glassy basalt at the contact with the diopside rock is changed to this green color for a distance of about 5 millimeters. Under the microscope this green glassy basalt has precisely the same appearance as the normal purplish glass and the line of contact between the two can not be distinguished in the thin section, although the glass is banded in more and less transparent bands parallel to the contact. It may be recalled from the description of hydrothermal alteration of the diabase of Goose Creek that the principal effect of the solutions was removal of some of the iron of the original augite and the changing of this high iron pyroxene to pale green or colorless diopside. The effect here on the basaltic glass has probably been a similar substitution of bases although it is not susceptible of proof by microscopic examination.

Many specimens of the crystalline basalt of the dikes show narrow seams and veinlets cutting the normal rock. These have a central white seam averaging ½ mm. in width bordered on either side by a dense olive green layer about 1 mm. wide beyond which is a bleached greenish band from 1 to 2 mm. wide which shades into the normal rock. Under the microscope these bands are not so conspicuous. The central filling is composed of granular datolite. The dense greenish band is largely pyroxene, apparently an enrichment by enlarging the original grains of the rock. The outer bleached streak presents no conspicuous difference from the adjacent normal basalt under the microscope except that the pyroxene looks clearer and less colored while by comparison that of the adjacent unaltered basalt appears brownish. It seems most probable that this alteration is, like that observed in the Goose Creek diabase, diopsidization of the augite. The outer band contains scattered grains of pyrite.

HYDROTHERMAL MINERALS REPLACING THE LIMESTONE

As has been previously pointed out, large amounts of diopside and diopside-garnet rock are developed adjacent to the basalt dikes or, probably better, in and adjacent to the shear zone which is associated with the dikes where they are exposed on the east side of the quarry. These lime silicate rocks are fine grained and lusterless, with dull green to brownish green and brownish gray colors. Their relations are not clear, and perhaps the best method of describing them is to describe the several specimens collected as typical of the several variations.

The writer's No. "Lb–3" in the hand specimen is a sugary granular dull green rock showing no minerals clearly identifiable with the unaided eye, except a little coarse calcite. It shows ghost outlines

of the original conglomeratic structure, remnants of the original pebbles showing either as deeper green or browner green masses or as incompletely replaced granular areas richer in calcite than the matrix. Under the microscope this is seen to consist predominantly of diopside, with less calcite, garnet, and serpentine. The diopside is fine granular, colorless, and of normal optical properties, and is anhedral except where it projects into calcite or serpentine there forming short, stout prisms. The garnets are hexagonal in outline and are anomalously birefracting, some with division into sectors. The centers of some are isotropic, the outer border having a relatively high birefringence, while others show a uniform low order blue interference color. Occasionally they have yellow-brown cores. The serpentine forms fine flaky colorless interstitial areas or fills cracks in the diopside, and is probably the latest mineral in the section.

"Lb–4" is a massive granular lusterless rock like the last but of a more yellowish green tone. Pebbles of the original structure are shown by masses of more yellowish color dotted with dark specks. This contains much less visible calcite than "Lb–3." Under the microscope this rock is also found to consist principally of granular diopside, with large poikilitic crystals of a uniaxial positive mineral of low birefringence and high refractive index which is probably vesuvianite. Groups of small colorless isotropic garnets and a little flaky interstitial serpentine occur.

"Lb–5" is a dense fine-grained rock having a greenish-gray to lilac-gray color dotted with dark spots only about 0.2 mm. in size, which give the rock a speckled "pepper-and-salt" appearance. Under a lens these dark spots, which look like minute manganese oxide stains, are seen to be resinous and lustrous. They are small patches of garnet. Under the microscope this rock is found to be composed of calcite, diopside, and garnet in roughly equal amounts. The calcite, which is a fabric of coarse interlocking grains, forms a matrix in which the other minerals have developed, probably by replacement. The diopside is colorless and of normal optical properties. It occurs as large ragged and irregular crystals inclosing much calcite and also as radial aggregates of slender prisms. The garnet forms granular areas, ragged in outline and including much diopside. It is completely isotropic, and varies from colorless to resinous brown.

One section was cut showing the actual contact between glassy chilled basalt and the lime-silicate rock. The latter is made up of coarse and fine granular diopside, sharply euhedral garnets, scattered large vesuvianite grains and interstitial patches of serpentine and calcite. The body of the rock and the earliest mineral now shown

by the section is diopside, which includes the later large ragged and poikilitic vesuvianites. The garnets have sharp outlines where they abut against calcite or serpentine and are isotropic except at the borders, where they have a narrow double refracting outer layer. They are grouped in a manner indicating that they probably developed lining minute cavities which were later filled with serpentine now largely replaced or saturated with still later calcite.

The replacement of the limestone by the high temperature solutions moving along fissures is well shown by the specimen illustrated in plate 1. The solutions were controlled by narrow fractures, seldom of any significant size. Along some of these there is some crushing and slickensiding indicating some movement, but in others they are simply weak cracks which have not been accompanied by any displacement at all. They vary somewhat in attitude and dip, ranging from some 60° to vertical, and in general have a north-south strike. Adjacent to this crack the limestone has been replaced by lime silicates, principally diopside with less garnet and serpentine, and some vesuvianite. This replacement extends to variable distances from the fissure. In the illustrated specimen the width of the central filled crack averages only about 2 millimeters, yet the replacement with development of abundant diopside reaches a distance of 10 centimeters from the crack and abundant magnetite has developed up to 4 centimeters away. The specimen is composed predominantly of two kinds of limestones in the usual sandy cement. The matrix of the pebbles has been preferentially replaced by the lime silicates while at the same distance from the fracture the coarse-grained gray-and-white mottled marble has not been attacked at all while a finer granular buff-white marble has been slightly replaced in porous streaks and along rifts. The controlling factor in the replacement has apparently been permeability. Near the fissure many of the fragments of limestone which did not yield to the alteration to lime silicates have been impregnated with fine scales of serpentine in concentric layers parallel to their outer surface. The magnetite has not replaced the lime silicates to any great extent but has developed principally by replacement of these serpentinized limestone masses, the structure of the replaced marble being retained in the structure of the magnetite.

The lime silicate rock is not so well individualized in these small replacements as in the large diopside rock masses previously described, the garnet being in the form of irregular and indistinct patches.

The central crack is lined with a layer of about 1 millimeter of diopside, overlain by a layer of minute magnetite grains following which the remaining open space was filled with coarse white calcite.

Thin sections from a second similar vein show the same relations. The central crack is filled with granular calcite containing disseminated magnetite grains and bordered by several alternate layers of diopside and magnetite. There are also layers of another bladed fibrous mineral of low birefringence, with an index of refraction of about 1.56. This mineral is optically positive and probably uniaxial. In optical properties it agrees with brucite or colerainite. It is probably a white chlorite allied to colerainite. Small cavities in the rock adjacent to the crack are lined with a botryoidal brown layer and filled centrally with pale yellow to colorless material which is isotropic at the borders to feebly birefringent with a fine confused fibrous structure at the center. These have the appearance of opal and chalcedony.

Another specimen shows abundant magnetite associated with the colorless chloritic material, and large anhedral areas of garnet which is colorless and isotropic and grades into a thick layer of garnet coating a slickenside along the parent crack. This garnet is largely replaced by a golden brown isotropic material of high refractive index which tends, in places, to form spherical globules each of which has a minute nucleus which appears to be a colorless octahedral crystal.

The minerals which occur as constituents of what are here called high temperature hydrothermal replacements may now be enumerated, with descriptions.

DIOPSIDE

Diopside is the most abundant of the minerals replacing limestone and makes up large masses of secondary lime-silicate rock as described above. It is always microscopic granular and never recognizable with the unaided eye. In thin section it is colorless with normal optical properties. Some of the masses of rock consisting predominantly of diopside are a meter or two in diameter.

VESUVIANITE

Vesuvianite occurs only as scattered microscopic grains, conspicuous in thin section but invisible to the unaided eye. It is a minor constituent of the lime-silicate rocks.

MAGNETITE

Magnetite occurs as fine granular masses adjacent to fissures in the limestone where it accompanies the various secondary silicates. It has chiefly formed by replacement of limestone masses adjacent to the fractures and is younger in age than the lime silicates and serpentine.

COLERAINITE

A mineral having the optical properties of colerainite was seen in a few thin sections as a miscroscopic mineral associated with magnetite along fractures.

GARNET

Garnet is an easily recognized microscopic constituent of the lime silicate rocks where it forms minute sharply bounded euhedral crystals. These vary from completely isotropic to rather notably doubly refracting, with division into sectors. Some crystals have an isotropic core with a birefracting border. The mineral also forms irregular poikilitic areas in diopside rock which appear to the unaided eye as black specks giving a "pepper and salt" appearance in the hand specimen.

Garnet forms large and somewhat irregular areas associated with magnetite along fissures. This garnet is nearly colorless, isotropic, and devoid of crystal outlines. With it is associated another isotropic substance of unknown character which has a golden brown color and index of refraction below that of the garnet but still very high. This brown mineral seems to replace the garnet and in places tends to form globular masses, each of which contains what appears to be a minute colorless octahedron having the index of the garnet.

The most unusual garnet found in the quarries is obtained as a coating on slickensides. Many of the small fissures along which high temperature replacement of the limestone with diopside, magnetite, etc., has taken place are not healed but have been kept open by slight movements which have produced slickensides. These slickensides are coated, to an average depth of several millimeters, with a green material which has all the appearance of serpentine, which might be expected to occur in such manner. These were thought to be serpentine in the field but the specimens of them collected were found to be garnet when further examined. This garnet is so unusual in appearance and occurrence as to warrant a detailed description.

The coatings are associated with magnetite, diopside, etc., which have developed in the adjacent rock and are usually well polished by slickensiding. They have a pale serpentine green color, and are dense with an opaline texture and waxy luster and subconchoidal fracture. Like some amorphous minerals they tend to contract with the formation of cracks which disintegrate them somewhat. The material was found upon microscopic examination to be isotropic with a refractive index above 1.82, the highest oil at hand. A pure piece of the mineral was selected for analysis, ground and treated

with dilute acid to remove a little calcite present as impurity. The resulting material was homogeneous garnet but varied in color under the microscope from transparent colorless to brown, the brownest material being faintly anisotropic but grading into the isotropic material with lessening of the color. The analysis gave the following results:

Analysis of slickensided garnet coating

SiO_2	33.23
Al_2O_3	4.65
Fe_2O_3	26.37
FeO	.04
CaO	34.18
MgO	Trace
H_2O	1.79
Total	100.26

The analysis shows the material to be garnet, principally of the lime-iron molecule andradite with a little of the lime-alumina molecule, grossularite.

SERPENTINE

Serpentine is common though not abundant in the lime silicate rocks as fine scaly interstitial material. It frequently replaces limestone pebbles to a slight extent as disseminated grains scattered throughout the pebble. Sometimes small flat thin fragments of limestone in the breccia are completely replaced by oil green translucent serpentine when it becomes conspicuous to the naked eye. In other cases a layer of pale yellow green waxy serpentine from a millimeter to a centimeter thick surrounds a rounded pebble of dense white marble as a continuous envelope, and penetrates it along cracks. In thin section this serpentine is clearly seen to be a replacement of the calcite of the marble and to vary from isotropic through fine scaly material of low birefringence to coarser flakes of high birefringence.

XONOTLITE

The calcium silicate described as a new mineral from California[5] and later shown to be identical with xonotlite[6] was identified in a single specimen found loose on the floor of the Leesburg quarry by Doctor Schaller. The xonotlite forms rounded patches up to 5 or 6 centimeters in diameter, surrounded by rims from 1 to 4 millimeters wide of cross fibered pale bluish green material which is largely

[5] Esper S. Larsen. Eakleite, a new mineral from California. Amer. Journ. Sci., vol. 43, pp. 464–465, 1917.

[6] Esper S. Larsen. The identity of eakleite and xonotlite. Amer. Mineralogist, vol. 8, pp. 181–182, 1923.

calcite mixed with some fibrous silicate. After treatment with cold dilute acid there remains a residue of fibrous material of very low birefringence with a refractive index below 1.50. This may be silica from the decomposition of thin wollastonite fibers. The interstices between the xonotlite areas are filled with pearly granular wollastonite.

This xonotlite, like those previously described from other localities, is densely fibrous and very tough. When freshly broken the mineral is distinctly pink in color and somewhat translucent but upon exposure to air the pink color gradually fades and the mineral becomes more opaque at the surface with a chalky appearance. A selected fragment from the center of one of the purer masses was analyzed yielding the results given in the following table. The sample was not of very pure material as it was shown by microscopic examination to contain two minerals as impurity, amounting to several per cent. The most abundant of these was apparently diopside, the second probably thaumasite.

Analysis and ratios of compact xonotlite from Leesburg

Constituent	Per cent	Ratios	Constituent	Per cent	Ratios
SiO_2	45.62	0.757 } 0.110×7	H_2O+110° C	6.00	0.333 0.111×3
$(Al, Fe)_2O_3$	2.05	.016	H_2O−110° C	1.00	
CaO	41.28	.736 } .113×7			
MgO	2.26	.056	Total	98.21	

The ratios give the formula $7CaSiO_3.3H_2O$ as compared with the $4CaSiO_3.H_2O$ or $5CaSiO_3.H_2O$ of previous analyses. This may be due to water absorbed in the fine fibrous mass. The material used for analysis was too impure to do more than establish the identity of the species.

Under the microscope the mineral is finely fibrous with parallel extinction and positive elongation. The refractive indices are somewhat variable, the average being, α=1.580 γ=1.592.

The xonotlite-bearing mass found loose and its original position in the quarry is not known. It was near the eastern wall and may have come from the vicinity of the basaltic dikes. Although specially sought, none of the mineral could be found on several subsequent visits.

When the field trip party of the Mineralogical Society of America visited this locality following the Christmas, 1923, meeting, a very different type of xonotlite was found, in thin seams in relatively unaltered limestone in the north end of the quarry. This formed veinlets up to 5 mm. wide filled with flaky fibrous xonotlite with pearly luster and pale pinkish color which greatly resembles the

coarser varieties of pectolite. The feel is harsh and needles break off and enter the fingers as splinters like pectolite. The xonotlite is mixed with calcite and some of the fissures have an earlier layer of datolite next the wall. The needles form radiating bundles and rosettes on the crack-surfaces, sometimes 3 cm. across. Under the microscope these lie on a perfect cleavage which is probably perpendicular to the obtuse bisectrix. If this be taken as $b(010)$ the optical orientation is $X=b$, $Y=a$, $Z=c$. The elongation of the needles is positive and they give parallel extinction. The mineral is biaxial positive with 2V probably small. The refractive indices are $\alpha=1.583$, $\beta=1.583$, $\gamma=1.595$. The material gave the following composition upon analysis:

Analysis of coarse xonotlite

SiO_2	49.60
Al_2O_3	1.00
CaO	46.32
$H_2O+110°C$	2.80
$H_2O-110°C$	None.
Total	99.72

THAUMASITE

Certain glassy transparent grains making up about 1 per cent of the first analyzed sample of xonotlite were not fibrous, had a fairly high birefringence and were uniaxial negative with $\omega=1.505$ and ϵ decidedly lower. These, to judge from their optical properties, were probably thaumasite. The analyzed sample gave faint qualitative reactions for carbonic and sulphuric acids.

WOLLASTONITE

Small interstitial areas between the masses of xonotlite are filled with a glistening material of fine bladed structure varying in color from pearly white to pale greenish. This material, when powdered and examined under the microscope, yields laths with parallel extinction, biaxial negative, 2V small, $r<v$ weak, Y=elongation, β above 1.62. This is doubtless wollastonite. It is difficultly distinguishable, with the naked eye, from the crystalline calcite of the marbles and, although none was found on a later visit to the quarry, the mineral may not be uncommon.

DISCUSSION

The foregoing descriptions may now be summarized. Magmatic solutions, emanating from diabase, have traversed fissures penetrating overlying limestone and have largely replaced the rock adjacent

to the fissures with secondary silicates. These are principally diopside and andradite garnet, with less vesuvianite and serpentine, and a little wollastonite, xonotlite, and thaumasite. Magnetite was later introduced in considerable quantity. The order of formation of the most important minerals was diopside, vesuvianite, garnet, serpentine, and magnetite.

This assemblage of secondary silicates is entirely like that found in so-called lime-silicate contact zones and, because of such lime-silicate zones frequently being associated with workable deposits of copper or iron ore, they have been carefully studied by a number of able geologists, and the literature relating to them is rather voluminous. A majority of the authorities who have done detailed work on deposits of this type agree in assigning the source of most of the material of the so-called "garnet-zones" to emanations from the cooling magma and consider that there has been a large addition of material, notably silica and iron, from the igneous rock. There is an alternate opinion supported by some, however, which holds that there has been relatively little material added from the magma and that the lime silicates have formed by simple combination of the lime of the limestone with the impurities already present to form the silicates, under the influence of the heat of the intrusive, the excess of calcium carbonate having been removed from the vicinity. It is not desired to enter here into an exhaustive review or discussion of the two theories nor of the various phenomena which characterize lime-silicate zones in general. The literature of the subject has been reviewed in detail in a paper by Uglow[7] who favored the idea that the recrystallization of the materials of the limestone was the process of fundamental importance in the production of the lime-silicate zones. The discussion provoked by this opposition to the favored view was entered into by a large proportion of the leading American authorities on the subject.[8] The concensus of opinion is that both processes are operative, but the majority favor the conclusion that the addition of material from the magma has greatly overshadowed the mere concentration of impurities by reduction in volume in most of the known cases.

While the term "contact zones" is generally used for these lime-silicate masses, they are characterized, usually, by marked irregularity of distribution, even about a single intrusive mass. In some places great quantities of the silicates are developed at one point

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[7] W. L. Uglow. Review of the existing hypotheses on the origin of the secondary silicate zones at contacts of intrusives with limestones. Econ. Geology, vol. 8, pp. 19–30 and 215–234, 1913.

[8] Econ. Geol., vol. 8, 1913, pp. 501–507 (C. A. Stewart), and pp. 597–610 (J. F. Kemp); vol. 9, 1914, pp. 73–77 (D. F. Higgins); pp. 175–183 (W. L. Uglow); pp. 278–281 (C. A. Stewart); p. 282 (J. F. Kemp); 283–292 (W. Lindgren); 292–299 (C. K. Leith); 593–594 (J. B. Umpleby).

in the contact while at other places, where the same igneous rock is in contact with identical limestone, no appreciable effect can be found. Sometimes secondary minerals form at a considerable distance from the intrusive as tabular bodies along fissures or as pipes and in many places the garnetization follows single beds for a long distance from the contact while the other beds of the series are completely unaltered. The latter phenomena have been explained by the proponents of the residual crystallization theory as being due to impurities, capable of forming secondary silicates, in the replaced beds while the unreplaced beds were devoid of the constituents, notably silica, alumina, iron, etc., necessary to form the garnet and other silicate minerals; but several authors have shown that this does not hold true for in many cases it is the purer beds which have been converted to silicates.

The formation of these lime-silicate zones in limestone is in almost all cases at the contacts of acid rocks, basic rocks very seldom giving rise to such deposits. In the case of the Leesburg quarry, however, the lime silicates are formed adjacent to a diabasic intrusion. Referring again to the preceding Goose Creek paper, it may be recalled that it was there concluded that the heated magmatic solutions were released only after they had concentrated in residual areas in the magma and had induced differentiation in these areas so that the last rock to crystallize, preceding the release of the solutions, was a quartz albite rock. The solutions, as such, were thus in fact emanations from very acid rocks, despite the small amount of the acid rocks and their derivation from a great body of basaltic magma. These solutions were not stable in contact with the already solidified basalt but reacted with it adjacent to the fissures which formed channels for their escape, metasomatically replacing augite by diopside, plagioclase by albite and sericite, and magnetite by titanite. It is these solutions which, escaping along fissures in the limestone, accomplished the mineralization described in the present paper. This small-scale process of elimination of concentrated solutions at the final consolidation of acid end products of differentiation is, if we may credit modern petrologic theory, precisely what has happened in the larger batholithic masses of relatively acid rocks.

Emanations, by which is here meant principally water solutions, may be given off in the earlier stages following the intrusion of a batholith into its chamber, particularly if it be saturated with volatile materials, but it seems improbable that a high degree of saturation often obtains. The water enters the magma chamber in solution in the magma. There must be some essential difference in the behavior of water in abyssal chambers crystallizing to give a plutonic rock of granitoid texture and in a stock crystallizing at moderate depth.

In the former case it may be presumed that there was no means of escape for the contained water and it was retained until final consolidation, the expulsion of the water being the result of crystallization. In the case of hypabyssal intrusions, forced into magma chambers at moderate depth, on the other hand it may be conceived that the surrounding rock was to some extent permeable, permitting the escape of some of the vapors and corresponding reduction of the vapor pressure of the magma. Such action might be expected to give general contact action by the magma on its walls proportional to the porosity or permeability of the confining rock at any given point. If this rock were limestone the extent to which it was affected would be dependent on its permeability, a property not directly connected with its chemical or mineralogical composition.

Such loss of volatile constituents of the igneous mass, by permeation of the enclosing walls, results in a decreased vapor pressure in the mass of fused material and a lessening of the content of dissolved gases. It would thus act to constantly raise the point of consolidation of the magma and, taking place concurrently with loss of heat by diffusion into the surrounding rocks, would inevitably hasten the final consolidation. Since the presence of phenocrysts, carried already crystallized in the magmas filling many such bodies, precludes the idea that they were greatly superheated when intruded, the combined influences would tend to crystallize them rather quickly with little opportunity for further differentiation. At the crystallization of the mass as a whole, however, the remaining volatile constituents, including the remainder of the water must be expelled, either through the consolidated rock as a mass or through fissures which might be developed from the act of crystallization or by some outside agency. If the final elimination of water took place uniformly without fissures it might be expected to continue to move as the earlier emanations had moved, controlled by the permeability of the surrounding rocks. In most cases, however, fractures seem to have developed at the critical moment, giving localized channels for the escape of the materials. These late emanations doubtless were laden with materials in solution and were capable, in their earlier and hotter stages, of producing lime-silicate mases like those resulting from the earlier emanations. Whether the materials carried in solution at a given place outside the magma were the original constituents of the solutions at the moment of crystallization or whether they are the result of reactions and substitution in the traversed rock, where they have produced alterations so generally as to be difficultly demonstrable, can not in all cases be determined. Sericitization of the feldspar seems a common effect of such late solutions and this can be detected, but minor substitutions might take

place extensively without obvious effect. In the examples which, because of their economic importance have received much careful study the solutions have produced, in their early stages, when enclosed in limestone, garnet zones, while at greater distance or in different surroundings and under other conditions they gave rise to metalliferous veins. There is no real difference between metalliferous veins, such as are widely known, on the one hand and the less conspicuous zeolite-bearing veins arising from basaltic rocks on the other hand, and ore minerals are frequently noted in association with the zeolites while zeolites are not infrequent in association with valuable ores.

At Leesburg the solutions emanating from the crystallizing diabase have penetrated the limestone, after some reaction with the traversed igneous rock, and have followed fissures replacing the limestone adjacent to these fissures by lime-silicates. The most abundant mineral is diopside, followed by garnet and vesuvianite and later serpentine, followed by magnetite. The diopside replaced, first, the porous material of the calcareous sand groundmass and, later, the more porous of two kinds of marble making up the pebbles of the conglomerate, leaving even small pebbles of the other less porous marble isolated in a diopside groundmass. The serpentine-forming solutions coming later penetrated these residual pebbles of limestone, coloring them with disseminated flakes of serpentine and surrounding them with a serpentine crust. The magnetite moreover replaced these serpentinized pebbles of limestone in preference to the previously formed diopside and garnet of the matrix. Advocates of the origin of lime-silicate zones by decrease in volume and recrystallization might maintain that the presence of clay and sand as impurities in the groundmass was the controlling factor in this localization. The attitude of the silicates along a fissure in unaltered rock shows, however, that whatever agency created them traveled along, and confined itself to the immediate vicinity of, the fissure. Moreover, the structure of the conglomerate is retained, showing that there has been no considerable decrease in volume or concentration of impurities. The process has apparently been entirely metasomatic and volume for volume without any alteration or loss of structure. It is conceivable from a study of the specimen illustrated in plate 1 that, assuming the limestones to have been a bedded series instead of the conglomerate, the buff marble might have been completely converted to silicate rock while the gray and white marble remained unchanged or was replaced by magnetite, it being assumed, of course, that the supply of replacing solutions was adequate and not limited as in the illustrated specimen. On the eastern side

of the quarry, where the action was more intense, all parts of the limestone have finally succumbed to the replacement.

It seems probable that the extent of the metamorphic replacement of the limestone at Leesburg is more or less coincident with and dependent upon the abundance of water in the underlying sill and upon the formation of pegmatites and acid differentiates in the sill. This mass thus behaved more or less as an abyssal chamber, retaining its volatile emanations and concentrating them in differentiates.

Characteristic of a somewhat later phase of the activity of the solutions are the low temperature veins, corresponding to the zeolite veins at Goose Creek, which are described below as containing datolite and calcite with less apophyllite, diopside, and barite.

LOW-TEMPERATURE VEINS

Under this heading are considered narrow fractures in the limestone containing fillings of calcite or, more frequently, datolite, and having numerous open spaces lined with datolite, calcite, and less of a peculiar form of diopside, apophyllite, and barite. These veins average only about 2 centimeters in width, although they widen out in places to 8 or more cm. with open centers. The veins fill open cracks which are apparently feeble breaks of practically no displacement. The open space which they have filled may in part be due to solution of the limestone along the break. The adjacent limestone is not conspicuously altered. These veins are considered to represent the material deposited from solution by emanations from the underlying diabase in the same manner that datolite with zeolites and prehnite were deposited in the veins in the diabase. The source for these vein minerals is thus the same as that of the materials added to the limestone to form the replacements composed of lime-silicate minerals and magnetite. The datolite-calcite bearing veins are considered to represent a slightly later phase of deposition, marked by lower temperature and perhaps pressure, indicated by the fact that they cut the lime silicate rock but have produced no notable alteration where they have intersected the original limestone. The parent cracks which controlled the lime-silicate deposition described above are filled with calcite and datolite occurring in the cracks along which the basalt has been hydrothermally altered. In general the deposition of the later veins followed new fractures, but the veins are linked to the high temperature replacements by a number of features in common. Calcite veins cut the lime silicate body on the east side of the quarry and one of these had a central filling of chalcedony like that observed in thin section in lime silicate rock. Moreover, diopside, the most abundant product of the lime silicate replacement, occurs as a true vein mineral intimately associated with the datolite.

It is not believed that there can be any separation into two distinct phases of alteration and deposition of secondary minerals and there is probably every gradation from the so-called high-temperature replacements to the presumable low-temperature veins. The fact that the low-temperature veins are later in the observed cases than the lime-silicates merely indicates that they were formed by superposition at a period when the environment had become cooler, either by the dying stage of the same current of material or by a new pulse of solutions ascending along new fractures, from a deeper part of the sill. In the earlier stage, the zone characterized by deposition of datolite was well beyond that where the diopside and associated minerals were formed.

The minerals occurring in the veins are separately described below.

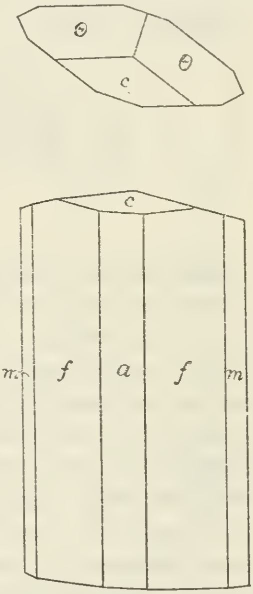


FIG. 1.—DIOPSIDE. HABIT OF MINUTE COLORLESS CRYSTALS OCCURRING IN VEINS WITH DATOLITE

DIOPSIDE

Some of the specimens of crystallized datolite show minute translucent white blades which are aggregated into masses, sometimes filling a small cavity, and resembling frost crystals. In most cases the mineral rests upon the bare portions of the limestone base of the specimens where they are not coated by datolite. Sometimes a completely bounded datolite crystal is impaled upon one of the minute blades. In a few cases they seem to rest definitely on the crusts of datolite crystals as though younger. The amount of the mineral is so small that it was with difficulty that 4 milligrams of pure material was obtained for qualitative testing. It is infusible before the blowpipe, insoluble in acids, and suffers no loss on ignition. Its constituents are silica, lime, and magnesia in approximately equal amounts. Optically the laths are biaxial positive with 2V medium, dispersion pronounced $r<v$. In some positions the extinction is parallel with positive elongation, in others the extinction is inclined with $Z\wedge c=44°$. The refractive indices are $\alpha=1.670$, $\beta=1.680$, $\gamma=1.690$, $\gamma-\alpha=.020$. All of these properties unite to identify the mineral as diopside, although it looks more like a zeolite and its occurrence and appearance are so unlike those of a pyroxene that the identification was reluctantly accepted.

One of the best of the minute crystals yielded approximate measurements sufficient to identify the forms, after the other properties had served to identify the mineral. The angles are given in the following table. The flat lath-like form is due to the predominance of the prism *f*(310). The habit of the measured crystal is shown in figure 1.

Measurements of vein diopside, Figure 1

Form		Symbol		Quality; description	Measured		Calculated	
No.	Letter	Gdt.	Miller		ϕ	ρ	ϕ	ρ
					° ′	° ′	° ′	° ′
1	*c*	0	001	V. p. minute	90 00	14 06	90 00	15 51
2	*a*	∞0	100	V. p. minute	93 00	88 00	90 00	90 00
3	*m*	∞	110	V. p. minute	43 30	90 00	43 38	90 00
4	*f*	3∞	310	V. p. minute	72 00	90 00	70 41	90 00
5	θ	−1⅓	$\bar{3}13$	V. p. minute	55 42	20 17	54 36	18 44

ANHYDRITE? MOLDS

Many of the specimens of datolite from Leesburg contain tabular hollow cavities, now empty or partially filled with a late deposit of calcite, which evidently owe their form to crystals of some mineral which has now been completely removed. Many of these cavities are mere gashes showing the mineral to have been very thin tabular and they have often formed parallel aggregates or slightly divergent sheaves of plates and in a few cases rosettes of thin tables radiating from a center. In size the gashes range from exceedingly thin ones with a length of 1 or 2 millimeters to an extreme size, in those examined, of about 3 by 20 millimeters in cross section. The cavities are rectangular in cross section and no impresions of terminations could be made out (See pl. 3).

These are entirely similar to the tabular empty cavities so common in zeolite specimens from the New Jersey localities and to similar impressions or molds which have also been noted at Westfield and elsewhere in Massachusetts and at Meriden, Connecticut. At some of these places they are associated with anhydrite which partly fills them, and it seems altogether probable that in all of the localities, including that at Leesburg, the cavities are the impressions of anhydrite crystals.

The minerals which preserve the cavities are datolite and calcite of the generation which formed immediately after the datolite but the anhydrite was removed earlier than the deposition of the later globular calcite which occurs in the crystal molds. The main generation of the datolite is later than the anhydrite but the cavities

do not penetrate quite to the base of the datolite layer so that they are probably approximately contemporaneous.

DATOLITE

Datolite is the most abundant mineral of the low temperature filled veins. The veins are narrow, averaging about 2 to 3 cm. in width, and are, throughout most of their length, filled with granular massive datolite of a translucent pale yellowish-green color. They open out into vuggy open spaces lined with crusts of crystals of datolite (pl. 2). Sometimes a vein so splits as to include flat pieces of limestone which are coated on both sides with datolite crystals. The datolite rests upon the brecciated limestone conglomerate which, adjacent to the veins, is comparatively unaltered. The crystals of datolite vary from pale transparent yellow green in the larger to opaque and white in the smaller. They reach a maximum diameter of about 7 millimeters.

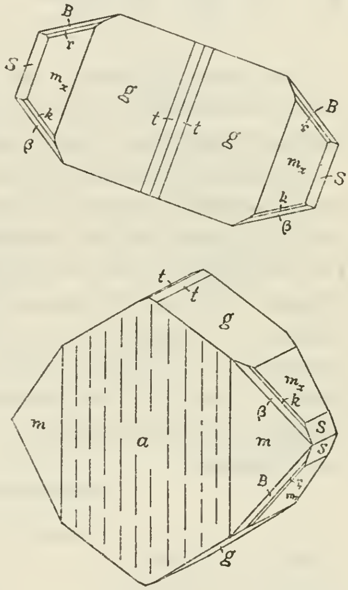


Fig. 2.—Datolite. Small crystal showing common habit with apparently orthorhombic symmetry

The crystal habit of most of this datolite is rather unlike that of any American datolite heretofore described. The crystals are thick tabular parallel to the front pinacoid *a* (100) and most of them, as shown in figure 2, are orthorhombic in habit. Quite contrary to the usual development of this mineral the positive and negative clinopyramids in a majority of the crystals are simultaneously developed. Most of the faces are not plane enough to afford good signals on the goniometer, and the crystals would be considered orthorhombic on the basis of these measurements, the deviation of datolite from orthorhombic symmetry being within their limit of error. Owing to the habit of the crystals it was found most advantageous to measure some of them in the Goldschmidt position; that is, with the *a* axis (Dana) vertical. The angle tables given below are in part made in this orientation and in part in the Dana orientation. The figures are all drawn in the Dana orientation and the indices given are the Dana indices. A small crystal of the habit shown in figure 2 gave the following measurements:

Measurements of datolite, Figure 2

Form		Symbol		Quality description	Measured		Calculated	
No.	Letter	Gdt.	Miller		ϕ	ρ	ϕ	ρ
					° ′	° ′	° ′	° ′
1	*a*	∞0	100	P. bunch	90 00	0 00	90 00	0 09
2	*S*	02	021	Medium	21 56	90 00	21 33	90 00
3	m_x	01	011	Excellent	38 25	90 00	38 18	90 00
4	*g*	0½	012	Medium	57 44	90 00	57 40	90 00
5	*t*	0⅓	013	V. p	68 41	90 00	67 07	90 00
6	*c*	0	001	V. p	91 12	90 00	90 00	90 00
7	*m*	∞	110	Excellent	00	32 28	14	32 24
8	*β*	12	121	Medium	21 33	53 57	21 39	53 47
9	*B*	−12	$\bar{1}21$	Fair	$\overline{21}$ 58	53 30	$\overline{21}$ 27	53 44
10	𝔫	+½ $\frac{3}{2}$	132	Medium	27 26	65 00	N. c.	N. c.
11	𝔯	−½ $\frac{3}{2}$	$\bar{1}32$	Dull	N. s.	N. s.	$\overline{27}$ 50	65 05

The letters, symbols, and indices of the above table are for the Dana orientation, while the calculated angles are for the equivalent indices taken from Goldschmidt's Winkeltabellen.

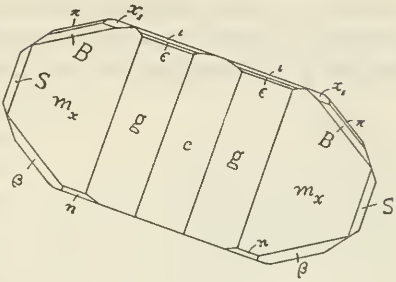
The larger and more highly modified crystals usually have some small negative pyramid faces developed without the corresponding positive forms or the opposite and, where the forms are the same, the faces of one end are slightly larger than at the other end of the crystal. Where the larger faces are of forms occurring more frequently as negative forms they are made negative although the orientation is wholly arbitrary. One such crystal is shown in figure 3 and the measurements are given in the following table. This crystal was measured in the Dana orientation and the angles are so given.

Measurements of datolite, Figure 3

Form		Symbol		Quality description	Measured		Calculated	
No.	Letter	Gdt.	Miller		ϕ	ρ	ϕ	ρ
					° ′	° ′	° ′	°
1	*c*	0	001	Poor	90 00	0 00	90 00	0 08
2	*a*	∞0	100	Excellent	90 00	90 00	90 00	90 00
3	Δ	2∞	210	V. g	71 45	90 00	72 24	90 00
4	*m*	∞	110	V. g	57 42	90 00	57 37	90 00
5	*o*	∞2	120	V. g	38 03	90 00	38 14	90 00
6	*g*	0½	012	Good	0 38	32 39	0 14	32 19
7	m_x	01	011	Ex	0 12	52 18	0 07	51 41
8	*S*	02	021	Good	0 12	68 00	0 04	68 27
9	*n*	+1	111	V. p	57 47	67 30	57 38	67 04
10	*β*	+12	121	Ex	37 35	72 48	38 15	72 14
11	*π*	−23	$\bar{2}31$	Good	$\overline{46}$ 10	79 40	$\overline{46}$ 24	79 24
12	*B*	−12	$\bar{1}21$	Good	$\overline{38}$ 06	72 55	$\overline{38}$ 12	72 46
13	x_1	−³/₂ 2	$\bar{3}42$	V. g	$\overline{49}$ 48	$\overline{75}$ 31	$\overline{49}$ 45	75 41
14	*ι*	−1½	$\bar{2}12$	Good	$\overline{72}$ 50	$\overline{64}$ 37	$\overline{72}$ 23	64 26
15	*ε*	−½	$\bar{1}12$	V. p. dull	N. m.	N. m.	$\overline{57}$ 33	49 42

Another habit occurring as a variant among crystals of the preceding kinds is shown in figure 4. The same choice exists as in

the preceding as to whether the modifying pyramids and dome be made positive or negative. The five forms, however, are fairly common on datolite as positive forms and are much rarer as negative forms, hence the orientation adopted was as drawn. The crystal is unique, however, since in datolite negative hemipyramids are usually developed much more frequently and in greater number than are positive hemipyramids. The crystal shown in figure 4 gave the angles of the following table. As in the first table above it was found best to measure this with the a axis vertical and the table is composite, the indices, etc., being those for the Dana orientation, while the angles are for the corresponding forms taken from the Winkeltabellen.



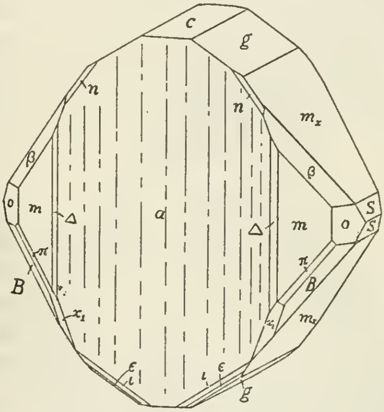
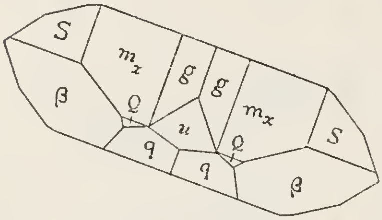


FIG. 3.—DATOLITE. SIMILAR TO FIGURE 2 BUT HAVING SOME NEGATIVE PYRAMIDS NOT REPRESENTED BY CORRESPONDING POSITIVE FORMS

Measurements of datolite, Figure 4

Form		Symbol		Quality description	Measured		Calculated	
No.	Letter	Gdt.	Miller		ϕ	ρ	ϕ	ρ
					° ′	° ′	° ′	° ′
1	a	∞0	100	P. multiple	90 00	0 26	90 00	0 09
2	Δ	2∞	210	Poor	30	18 31	28	17 26
3	m	∞	110	Good	30	33 06	14	32 24
4	o	∞2	120	V. p.	30	52 26	07	51 45
5	g	0½	012	Good	57 57	90 00	57. 40	90 00
6	m_x	01	011	Med	37 37	90 00	38 18	90 00
7	S	02	021	Good	22 00	90 00	21 33	90 00
8	u	+¼0	104	Med	90 00	63 56	90 00	63 31
9	q	+3/2 ½	312	V. g.	58 00	21 47	57 52	21 41
10	Q	+½1	122	Poor	39 27	57 42	38 33	58 17
11	β	+12	121	Excellent	20 00	54 05	21 39	53 47

In the several variations of the crystals above described the front pinacoid *a* (100) is marked by vertical striations, which make this form easy of identification and facilitate orientation of the crystals. The only other noteworthy feature is the presence of △ (210), ordinarily a rare form on datolite, which is present as narrow but distinct faces on nearly every one of the larger crystals. The negative pyramid x_1 ($\bar{3}42$) reported as a new form on datolite from Westfield, Massachusetts, is present as a small face on one of the measured crystals from Leesburg.



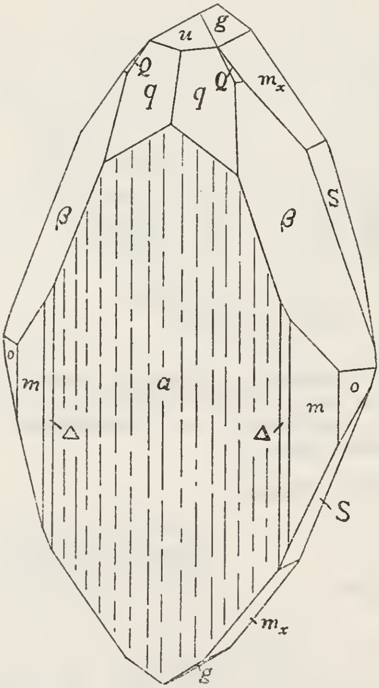


FIG. 4.—DATOLITE. SIMILAR HABIT TO FIGURE 3 BUT SHOWING ONLY POSITIVE HEMIPYRAMIDS

Although all of the datolite crystals of a large number of specimens from several veins had the general habit above described, one specimen, found loose on the east side of the quarry, contained crystals of distinctly different type. This specimen consists of brecciated limestone cemented by massive datolite containing vugs lined with colorless transparent crystals up to 6 millimeters in diameter, all of which have the development shown in figure 5. These are, in general aspect, like some crystals found in veins in diabase at Goose Creek quarry. They exhibit several forms which, while not new, have not been encountered on any datolite crystals which I have heretofore examined. The crystals are very thick tabular parallel to x (102), while the base *c* (001) is prominent, and the front pinacoid *a* (100) is a small and inconspicuous face. The one of these which was measured gave the forms and angles of the following table, oriented, as drawn, in the Dana position.

Measurements of datolite crystal, Figure 5

Form		Symbol		Quality description	Measured		Calculated	
No.	Letter	Gdt.	Miller		ϕ	ρ	ϕ	ρ
					° ′	° ′	° ′	° ′
1	*c*	0	001	Ex. 2 signals	89 37	0 00	90 00	0 00
2	*a*	$\infty 0$	100	Good	90 00	90 00	90 00	90 00
3	*m*	∞	110	V. g.	57 54	90 00	57 37	90 00
4	*o*	$\infty 2$	120	V. g.	38 50	90 00	38 14	90 00
5	m_x	01	011	Uniformly dull	N. s.	N. s.	0 07	51 41
6	*g*	$0\frac{1}{2}$	012	Excellent	0 30	32 31	0 14	32 19
7	*x*	$+\frac{1}{2}0$	102	Deeply corroded	N. s.	N. s.	90 00	45 00
8	*p*	$+\frac{1}{6}0$	106	Rounded, fair	90 00	18 32	90 00	18 31
9	*Z*	$+\frac{1}{6}$	116	V. g.	56 25	21 23	57 48	21 36
10	*Q*	$+\frac{1}{2}1$	122	Dull, etched	38 12	57 52	38 19	58 12
11	γ	$+\frac{1}{4}\frac{1}{2}$	124	V. p. dull	38 14	39 34	38 23	38 55
12	f	$+\frac{1}{4}1$	144	Excellent	21 12	53 54	21 36	53 43
13	New	$+\frac{1}{5}\frac{3}{10}$	2.3.10	Medium	47 37	28 57	46 26	28 51
14	ϵ	$-\frac{1}{2}$	$\bar{1}12$	Med., wavy	$\bar{5}7$ 02	49 41	$\bar{5}7$ 33	49 42
15	*Y*	$-\frac{3}{4}\frac{1}{2}$	$\bar{3}24$	Excellent	$\bar{6}7$ 20	58 23	$\bar{6}7$ 03	57 49
16	ν	-1	$\bar{1}11$	Etched dull	$\bar{5}7$ 02	64 01	$\bar{5}7$ 34	67 03
17	ı	-21	$\bar{2}11$	Fair	$\bar{7}2$ 44	78 34	$\bar{7}2$ 25	76 34

The faces of m_x (011), Q (122) γ (124), and u ($\bar{1}\bar{1}1$) are etched uniformly dull while *x* (102) is not merely dull but is deeply pitted and corroded. ε ($\bar{1}12$) and *Y* ($\bar{3}34$) are ribbed and striated parallel to their mutual intersection, a peculiarity since such striations on ε ($\bar{1}12$), almost invariably present on the crystals of this mineral from other localities, are usually parallel to its intersection with *m* (110).

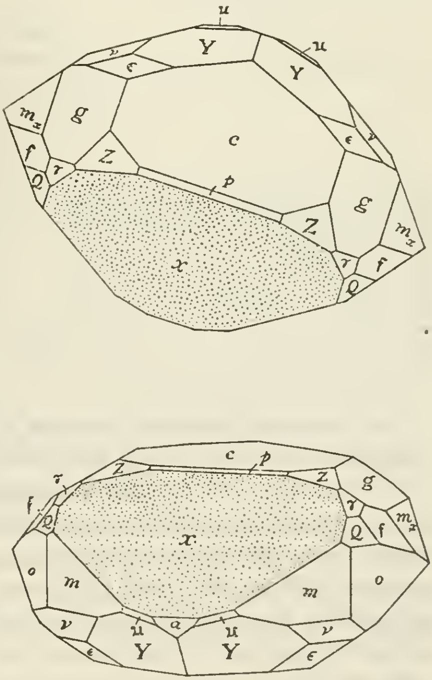


FIG. 5.—DATOLITE. CRYSTAL FROM A SPECIMEN ON WHICH ALL THE CRYSTALS, LIKE THE ONE FIGURED, ARE DIFFERENT FROM THE PREVAILING HABIT AT THE LOCALITY. SHOWS SEVERAL UNUSUAL FORMS

A small face, not shown on the drawing, which occurs between Z (116) and γ (124) gives angles indicating a new form with the indices (2.3.10). The negative pyramid u ($\bar{2}11$), recorded as a new form on datolite from Westfield, Mass., is here confirmed.

There is an alternate position possible for these crystals whereby the broad face indicated as *c* (001) in the drawing becomes *a* (100) and the small triangular face, above made *a* (100) becomes *c* (001),

x (102) remaining the same. The latter orientation makes a (100) prominent as in the previously described crystals, while the striations on ε ($\bar{1}12$) become normal in direction and Y (324) becomes λ ($\bar{1}13$). The assumption that the latter is the correct orientation would make it evident that the crystals were measured in the Goldschmidt, rather than the Dana, orientation. The angles measured may therefore be compared with those in the Winkeltabellen and the forms thus identified may be transposed to those for the Dana position. The angles are below compared with those for the Goldschmidt position and the equivalent indices for the Dana orientation are given in the last column.

Comparison of angles measured on datolite crystal, Figure 5, with angles for Goldschmidt position and equivalent indices for the two positions

Form		Goldschmidt indices	Measured		Calculated		Dana indices
No.	Letter		ϕ	ρ	ϕ	ρ	
			° ′	° ′	° ′	° ′	
1	a	001	89 37	0 00	90 00	0 09	100
2	c	100	90 00	90 00	90 06	90 00	001
3	g	110	57 54	90 00	57 40	90 00	012
4	m_x	120	38 50	90 00	38 18	90 00	011
5	o	021	N. s.	N. s.	07	51 45	120
6	M	011	0 30	32 31	14	32 24	110
7	x	101	N. s.	N. s.	90 00	45 09	102
8	s	103	90 00	18 32	90 00	18 36	302
9	q	113	56 25	21 23	57 52	21 41	312
10	Q	121	38 12	57 52	38 23	58 17	122
11	n	122	38 14	39 34	38 27	39 01	111
12	B	142	21 12	53 54	21 39	53 47	121
13	χ	235	47 37	28 57	46 40	29 01	534
14	ϵ	$\bar{1}11$	$\bar{5}7$ 02	49 41	$\bar{5}7$ 36	49 49	$\bar{1}12$
15	L	$\bar{3}22$	$\bar{6}7$ 20	58 23	$\bar{6}7$ 05	58 28	$\bar{1}13$
16	New.	$\bar{5}53$	$\bar{5}7$ 02	64 01	N. c.	N. c.	$\bar{3}$. 5. 10
17	New.	$\bar{9}52$	$\bar{7}2$ 44	78 34	N. c.	N. c.	$\bar{2}$. 5. 18

The above table shows that the alternate position gives no closer agreement in angles and, although the face which is a new form (2.3.10) in the first orientation becomes (534) an established form, two others which in the first orientation are v ($\bar{1}11$) and ϵ ($\bar{2}11$) established forms with simple indices, become new forms with the more complex indices ($\bar{5}53$) and ($\bar{9}52$) respectively. For these reasons the orientation as drawn is believed to be correct. The cause for the abrupt departure of the crystals of this specimen from the habit characteristic for the locality is not apparent.

APOPHYLLITE

Apophyllite is rare at Leesburg, occurring as scattered minute colorless transparent crystals, seldom 1 mm. long, resting upon crusts of datolite crystals. On other specimens the apophyllite is largely altered and is opaque white, and friable, many of the crystals being mere skeletons or shells.

Under the microscope the transparent unaltered crystals are uniaxial and positive with $\varepsilon = 1.535$, $\omega = 1.532$. They are for the most part poised upon needles of diopside and include the colorless vein diopside as numerous fibers.

The crystals, as shown in figure 6, are dominated by the unit pyramid *p* (111) with a short prism zone composed of small faces of *m* (110) rounded into faces giving angles approximating the form (780). The measurements follow.

Measurements of apophyllite, Figure 6

Form		Symbol		Quality description	Measured		Calculated	
No.	Letter	Gdt.	Miller		ϕ	ρ	ϕ	ρ
					° ′	° ′	° ′	°
1	*m*	∞	110	P. minute	45 00	90 00	45 00	90 00
2	New?	$\infty 8/7$	780	P. minute	41 04	90 00	41 11	90 00
3	*p*	+1	111	Medium	45 00	60 41	45 00	60 32

The apophyllite is definitely later than datolite and diopside and is probably earlier than all of the calcite.

BARITE

Barite was found in a number of specimens, all apparently from a single narrow but persistent vein. It rests upon crystallized datolite and is doubtless later than the datolite but its age relation to diopside, apophyllite and calcite could not be made out. The barite forms flat tables which reach a diameter of 3 centimeters, some of them being very thin. Many of the plates are curved and they tend to aggregate in sheaves (pl. 3). The surfaces of the plates are etched with a silky sheen but inside they are transparent and colorless with good cleavage. Small free plates are square tables with round corners and show no bounding faces.

The forms assumed by the barite are precisely those shown by the empty cavities assumed to have originally held anhydrite. The barite is, however, a rather insoluble mineral. There is no indication that it is removed in solution and its age relation to the datolite is different.

CALCITE

Calcite is an abundant mineral in the veins, probably as abundant as datolite, which is not surprising as the limestone of the walls is capable of furnishing any amount of calcium carbonate to be recrystallized in the open spaces. Some of the small filled veins contain only calcite. One flat seam in diopside rock above the uppermost of the two basalt dikes on the east side of the quarry averaged

2 to 3 cm. wide and was traceable for 2 meters. This was first filled with opaque white calcite crystals of the form φ $(\overline{22}41)$, 2 mm. in average diameter, to a thickness of 5 millimeters and was later re-opened along one wall and a later filling 15 millimeters wide of

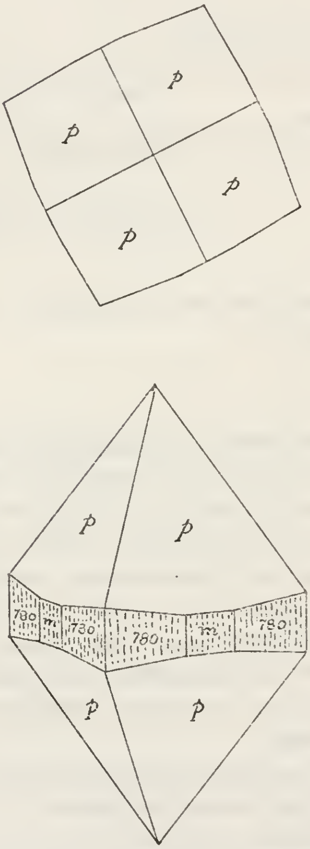


FIG. 6.—APOPHYLLITE. HABIT OF MINUTE CRYSTALS WHICH REST ON DATOLITE

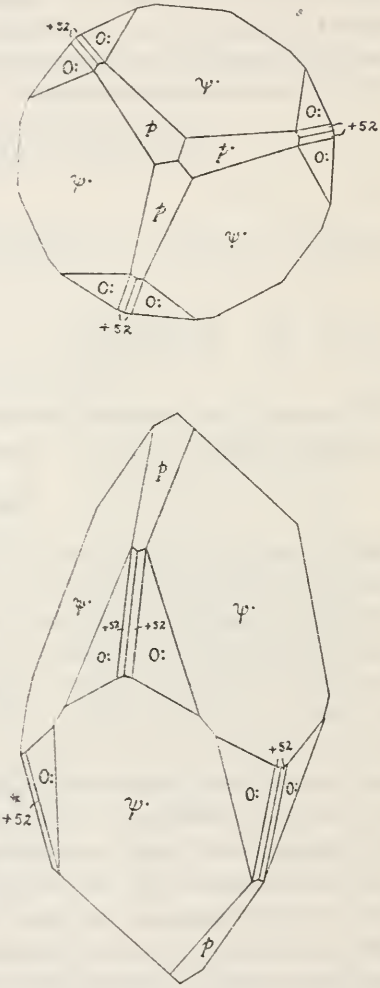


FIG. 7.—CALCITE. HABIT OF SMALL YELLOWISH TO AMBER CRYSTALS

yellowish transparent crystals of the form $(\overline{33}61)$ was then introduced, these averaging 5 millimeters in length. One small vug in this seam was filled with chalcedony.

Some specimens show datolite resting on coarse granular bluish calcite which is apparently older than the datolite. Most of the calcite crystals are, however, distinctly younger and rest upon the

datolite. The first and simplest type of these forms transparent pale amber "dog-tooth" crystals resting thickly upon free surfaces of small white datolite crystals. These average 4 mm. in length and have the habit shown in figure 7. Those which were measured gave the following forms and angles:

Measurements of calcite from Leesburg, Figure 7

Form		Symbol		Quality description	Measured		Calculated	
No.	Letter	Gdt.	Miller		ϕ	ρ	ϕ	ρ
					° ′	° ′	° ′	° ′
1	$^5/_2$	+1	$11\bar{2}1$	V. g.	30 00	44 31	30 00	44 36
2	ψ	$-^5/_2$	$5.5.\overline{10}.2$	P. dull	30 00	66 20	30 00	67 55
3	....	+52	$52\bar{7}1$	Med	15 32	75 35	16 06	74 18
4	Θ	+61	$61\bar{7}1$	Med	7 45	76 26	7 35	75 00

Another habit of calcite occurs as clear colorless and transparent to translucent crystals up to 2 centimeters in length resting on the larger datolite crystals. These calcites, which are associated with barite plates, have in general the habit shown in figure 8. The averages of the angles measured on several of these are given in the following table:

Angles of Calcite crystals of the habit of Figure 8

Form		Symbol		Quality description	Measured		Calculated	
No.	Letter	Gdt.	Miller		ϕ	ρ	ϕ	ρ
					° ′	° ′	° ′	° ′
1	ϕ	−2	$\bar{2}\bar{2}41$	Ex.	30 03	63 03	30 00	63 07
2	m	+4	$44\bar{8}1$	P. dull	30 00	75 33	30 00	75 47
3	Θ	−4	$\bar{4}\bar{4}81$	Med	29 51	76 30	30 00	75 47
4	....	−6	$\bar{6}.\bar{6}.12.1$	P. dull	29 51	80 52	30 00	80 24
5	ϵ	$-^3/_2$	$\bar{3}\bar{3}62$	P. blurred	30 03	56 16	30 00	55 57
6	p	+1	$11\bar{2}1$	Med	30 03	44 32	30 00	44 36
7	α	40	$40\bar{4}1$	P. etched	00	66 10	00	66 18
8	....	$-2^3/_2$	$\bar{4}\bar{3}72$	P.	25 20	60 10	N. c.	N. c.
9	$\mathfrak{D}$	$-\frac{20}{7}\,^8/_7$	$\overline{20}.\bar{8}.28.7$	P. blurred	16 11	63 37	16 06	63 48
10	n	+5	$5.5.\overline{10}.1$	Medium	30 17	78 21	30 00	78 32
11	χ	$-^9/_4$	$\bar{9}.\bar{9}.18.4$	V. p.	30 03	66 06	30 00	65 45
12	f	$+\frac{1}{2}$	$11\bar{2}\bar{2}$	Medium	29 56	26 22	30 00	26 15
13	K	41	$41\bar{5}1$	Good	10 16	71 48	10 53	69 02

A later deposit of calcite occurs as a minutely drusy botryoidal crust. This varies from a continuous crust which may envelope large crystals of the last described form, to minute spherical globules, and ranges in color from white through yellowish to smoky gray. The surface of this crust is made up of minute curved flat rhombohedral crystals. This deposit of calcite was formed after the removal of the anhydrite and occurs in places in the anhydrite cavities.

Chalcedony was found in megascopic masses only once as a purplish-gray filling of a cavity lined with calcite crystals. Its micro-

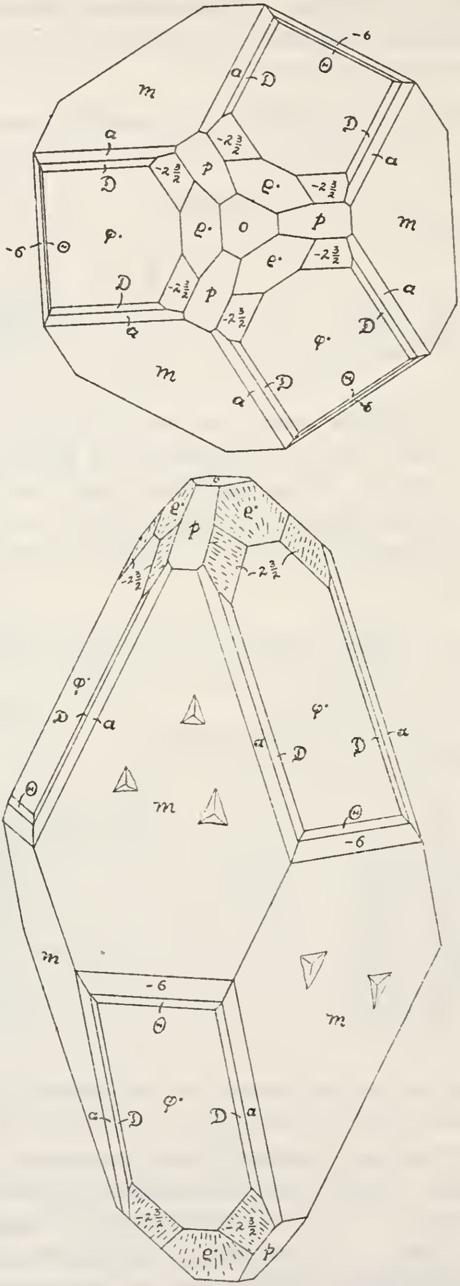


FIG. 8.—CALCITE. HABIT OF LARGER COLORLESS CRYSTALS

scopic occurence in lime-silicate rock has been noted above. The chalcedony is in the white earliest calcite in the calcite veinlet above

the basalt dikes as described above. It forms an irregular mass 15 millimeters in maximum diameter, varying from chalky white at the borders to translucent purplish gray in the center. It has the usual lusterless surface and flinty fracture.

EXPLANATIONS OF PLATES

PLATE 1

Replacement of limestone conglomerate along a narrow fissure. Shows the replacement of the calcareous sand forming the matrix of the pebbles by a mixture of diopside vesuvianite and garnet and, nearer the fissure, later replacement by magnetite. Two-thirds natural size.

PLATE 2

Crust of datolite crystals encrusting the walls of a narrow open fissure in limestone. Natural size.

PLATE 3

Upper left: Rectangular mold of anhydrite crystal preserved in datolite. Natural size.

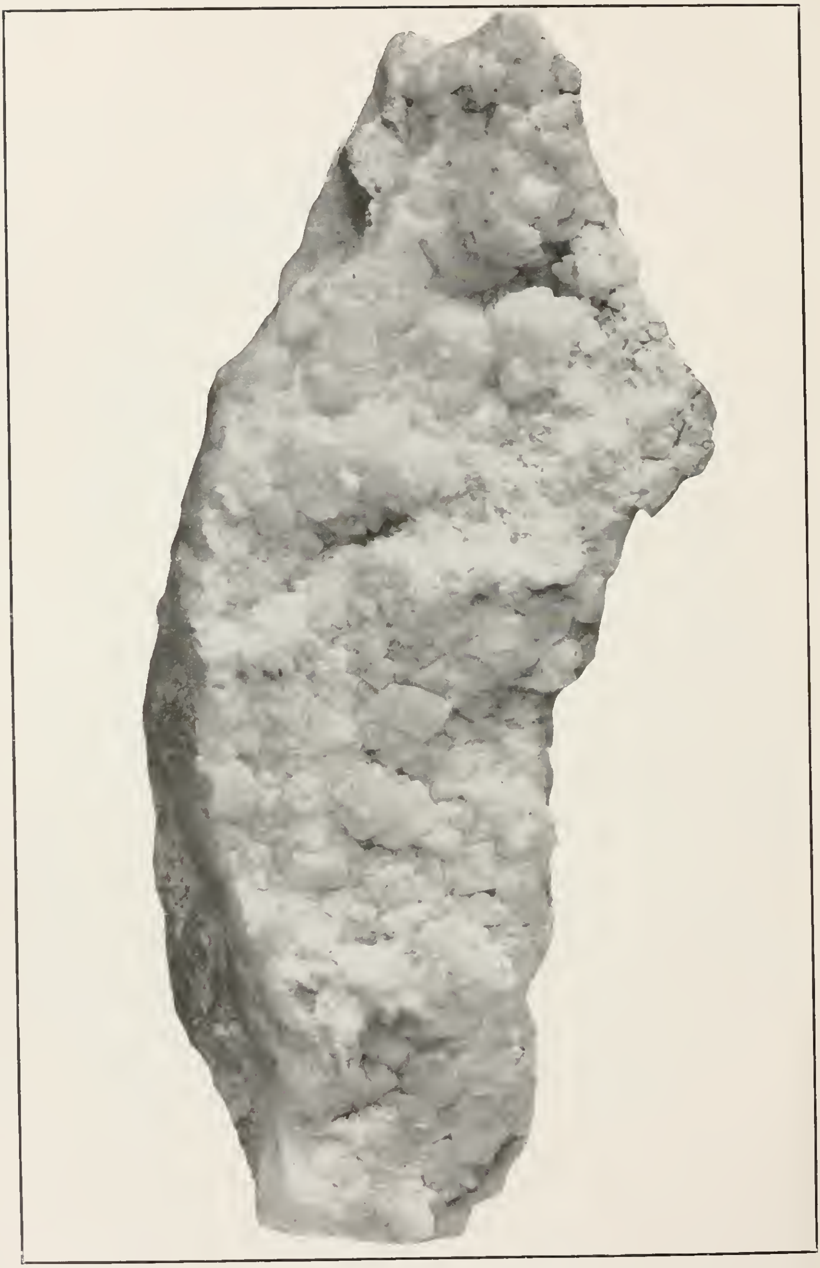
Upper right: Thin platy molds of anhydrite crystals preserved in calcite. Natural size.

Lower: Platy barite resting on datolite crystals. Natural size.

O

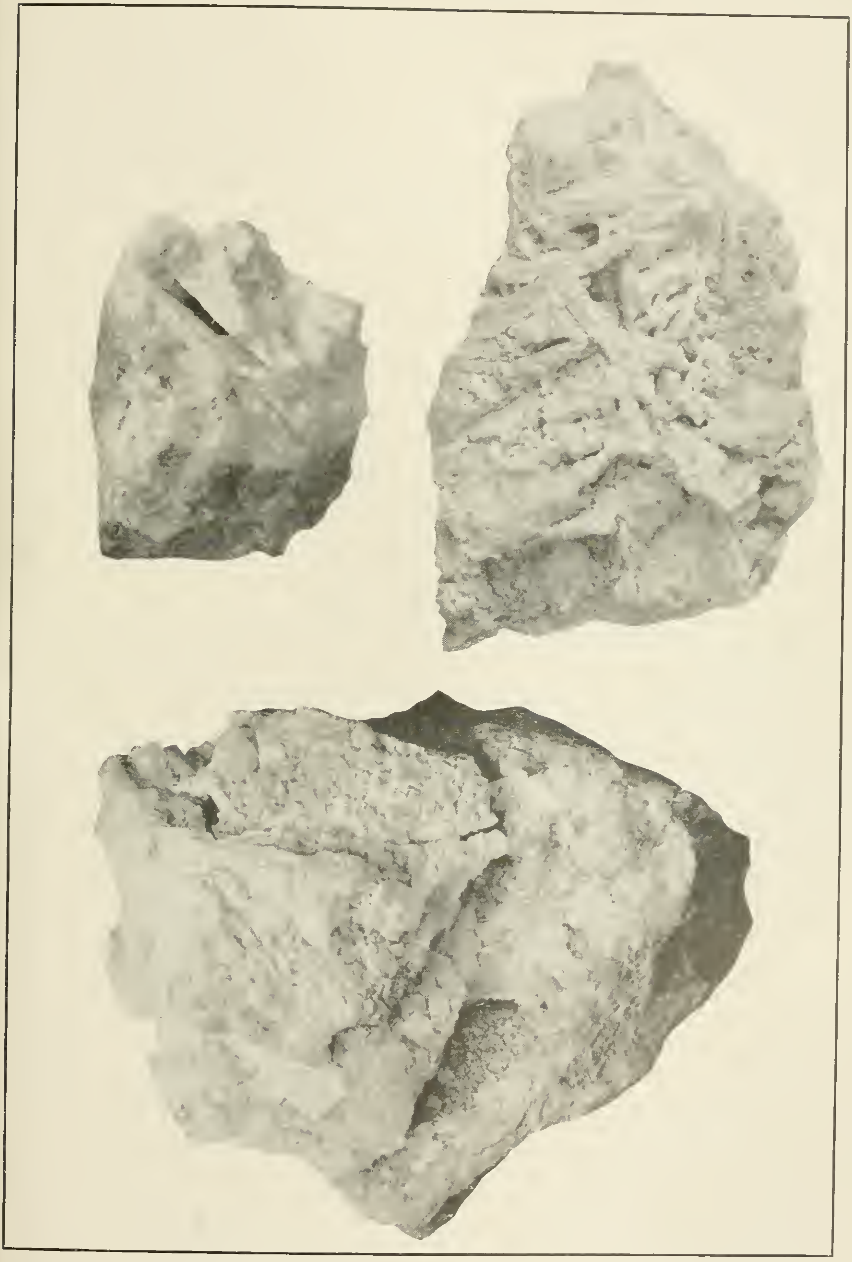
REPLACEMENT OF LIMESTONE CONGLOMERATE ALONG FISSURE

FOR EXPLANATION OF PLATE SEE PAGE 31



CRUST OF DATOLITE CRYSTALS

FOR EXPLANATION OF PLATE SEE PAGE 31



ANHYDRITE MOLDS, CALCITE, DATOLITE, AND BARITE

FOR EXPLANATION OF PLATE SEE PAGE 31

THE PUPARIA AND LARVAE OF SARCOPHAGID FLIES

By Charles T. Greene

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INTRODUCTION

The family Sarcophagidae has always been considered a very difficult group of flies and especially difficult in the immature stages. The adults are determined very easily by the male genitalia. These flies are very important from the fact that some species are parasitic on insects of great economic importance, while other species are parasitic on turtles and the higher animals, including man. Some species are parasitic and others simply scavengers in dead insects, mollusks, and decomposing animal matter, while certain species are either a parasite or a scavenger as the opportunity offers. The larvae of the genus *Wohlfahrtia* are found under the skin of young infants. There are also records of these larvae working under the skin of some of the lower vertebrates, such as the cat, dog, and rabbit. The larvae of Sarcophaga are often found in the nasal passages of man and also in open wounds of various animals. The larva of *Sarcophaga haemorrhoidalis* has been found in the intestinal tract of man on several occasions. The full-grown larva always leaves the wound and pupates elsewhere. The puparium is formed from the molted larval skin. So far as known none of the species of Sarcophagidae deposit eggs. All the species deposit first-stage larvae or maggots which start to work in immediately, and they develop very rapidly under favorable conditions.

Up to this time there has been no attempt to classify the larvae or pupae. In the larval and pupal stage the main character used for separating this family from the other muscoid flies is the absence of the button on the spiracular plate. This button is also absent in some species in the family Oestridae, but there can be no confusion because the larva and the puparium of this family are of an entirely

different form from that of the Sarcophagidae and are almost completely covered with very large chitinous spines. This button is located on the inner edge of the spiracular plate either near the middle or on the lower half. All of the pupae have a pit or cavity at the posterior end which I call the "posterior cavity." There are several species in the family Tachinidae which also have this posterior cavity but all of these Tachinids have a definite button on the spiracular plate. Within this cavity are located the spiracular plates and they are always located on the upper half of the cavity. It is very difficult to see these plates and it is also impossible to determine a species accurately without first cutting into this cavity. With a sharp knife and using a little care you can make a transverse cut which will divide the cavity into an upper and a lower half. After this operation the spiracular plates will be seen to be very distinct in each species. In the pupal stage the tubercles on the edge of the posterior cavity are quite variable in the various species and may be present or absent and this is due, I think, to the shrinkage in transforming and drying. However, the constancy of these tubercles in their presence or absence seems to be reliable within the species.

In the larval stage the tubercles around the edge of the posterior cavity are always present. The spiracular plate of the larva differs slightly from that of the puparium. In the larva this plate is generally a pale yellowish white in the central area with an amber color towards the upper or outer ends of the slits and with a very deep amber or dark brown ring around the edge. The ends of this outer ring appear to be separated at the lower end of the plate. In transforming to the pupal stage the appearance of the spiracular plate is changed by the entire plate changing to a deep red or black color, and in shrinking. the ends of this outer ring are contracted, causing the plate to be a little more pointed. The slits are of an amber color and darken a little in the pupal stage. The anterior spiracles are often of considerable value, but there is a possibility of variation in the number of lobes of each spiracle.

For details of the terms used in this paper see plate 1, figures 1 and 2. The dotted line shows the contour of the posterior cavity and just above the horizontal axis is shown the location of the spiracular plates.

I think the term *spiracular plate* is more appropriate and should be used in place of the term stigmal plate used in my former paper.[1] The right spiracular plate is drawn for each species.

[1] An illustrated Synopsis of the Puparia of 100 Muscoid Flies (Diptera), by C. T. Greene, Proceedings of the U. S. National Museum, 1921, vol. 60, article 10, pp. 1–39, pls. 1–20, No. 2405.

The number given to each species is the same in the table of species, description, and the figure on the plate.

The specimens used in this paper are labeled with the number herein given to the species and a reference to the number of this article.

Unless otherwise stated, the material is located in the national collection.

I wish to acknowledge my thanks to Dr. R. R. Parker, Dr. J. Bequaert, Dr. F. M. Root, and F. C. Bishopp for the loan and gift of some valuable material used in the preparation of this paper. The main portion of the material herein treated was from the National Collection and the collection of Dr. J. M. Aldrich, which is now a Part of the National Collection. I also had some material from the Gypsy Moth Laboratory at Melrose Highlands, Massachusetts.

TABLE OF SPECIES—PUPARIA

1. Puparium definitely wrinkled along the segmental lines-------------- 2
   Puparium not wrinkled as above-------------------------------------- 3
2. Segmental wrinkles distinct on at least half of the puparium; posterior cavity shallow, located centrally on the horizontal axis; posterior spiracular plates smooth without definite lobes.
   No. 1, **Sarcophaga cistudinis** Aldrich.
   Segmental wrinkles distinct on the anterior segments 1–4; posterior cavity deep, located on the horizontal axis but mostly above; spiracular plates with three distinct lobes, the inner one short.
   No. 2, **Sarcophaga communis, var. ochracea** Aldrich.
3. Posterior end of puparium with three black chitinized points on each side and above the posterior cavity; posterior cavity medium sized, elliptical, located on but mostly below the horizontal axis; posterior spiracular plates with three distinct lobes with all slits slightly arcuate.
   No. 3, **Sarcophaga communis** Parker.
   Posterior end of puparium without chitinized points------------------ 4
4. Puparium with a keel or ridge below the posterior cavity------------ 5
   Puparium without a keel or ridge at posterior end-------------------- 8
5. A narrow definite keel reaching from the posterior cavity to the anal opening------------------------------ No. 4, **Sarcophaga securifera** Villeneuve.
   Without a definite keel but having a definite rounded ridge below the posterior cavity-- 6
6. A broad, rounded, definite ridge connecting with the two tubercles at the anal opening; posterior spiracular plates with three lobes, slits narrow, sinuous; a narrow extension of chitin on the lower and outer edge of the plate---------------------------------- No. 5, **Sarcophaga cooleyi** Parker.
   With a ridge not well developed like the above---------------------- 7
7. A broad, flattened, slightly raised surface below the posterior cavity, with a large rounded tubercle each side of the anal opening; posterior cavity very large; spiracular plate with three definite lobes, pointed at the base; slits nearly straight----------------- No. 6, **Agria affinis** Fallén.
   Puparium not as above-- 8

8. Puparium with posterior cavity located above or below the horizontal axis---------- 9
Puparium with posterior cavity located on the horizontal axis-------- 10
9. Posterior cavity distinctly below the horizontal axis; spiracular plate rounded with a definite extension on the outer edge.
No. 7, **Sarcophaga eleodis** Aldrich.
Posterior cavity distinctly above the horizontal axis; spiracular plate without an extension; slits short and nearly straight.
No. 8, **Sarcophaga opifera** Coquillett.
10. Posterior cavity quite round with the edge flattened.
No. 9, **Sarcophaga subaenescens** Aldrich.
Posterior cavity not as above---------- 11
11. Posterior cavity extremely small---------- 12
Posterior cavity very large---------- 13
12. Posterior end of puparium slightly tuberculate; spiracular plates with three distinct lobes; slits short, broad, pointed apically.
No. 10, **Sarcophaga hunteri** Hough.
Posterior end of puparium more broadly tuberculate, with three segments a little indefinite; lobes smaller, slits short and narrow.
No. 11, **Sarcophaga atlanis** Aldrich.
13. Posterior cavity extremely large---------- 14
Posterior cavity medium sized to large---------- 15
14. Posterior cavity located centrally on horizontal axis; last two segments visible; spiracular plate rounded; slits narrow; two inner ones very long, outer slit noticeably shorter----- No. 12, **Sarcophaga fuscicauda** Böttcher.
Posterior cavity slightly quadrate (especially at base); spiracular plate with three broad slits; the plate has a broad extension on the upper and outer edges---------- No. 13, **Sarcophaga sternodontis** Townsend.
15. Posterior cavity large---------- 16
Posterior cavity medium sized---------- 17
16. Posterior cavity slightly semicircular, with yellowish pointed tubercles on the edge; spiracular plates with three narrow, nearly straight slits.
No. 14, **Sarcophaga australis** Aldrich.
Posterior cavity irregularly rounded, with greater portion below the horizontal axis; spiracular plate large, with three large lobes, each lobe with a long, broad slit---------- No. 15, **Sarcophaga sarracenioides** Aldrich.
17. Posterior spiracular plate without definite lobes---------- 18
Posterior spiracular plate with definite lobes---------- 19
18. Posterior cavity elliptical; located centrally on horizontal axis, edge of cavity with indications of tubercles; below the cavity is a definite outlined rounded area containing two rounded tubercles; spiracular plate about as broad as long; slits broad, pointed at the base.
No. 16, **Wohlfahrtia vigil** Walker.
Posterior cavity elliptical, with only the lower edge of the cavity touching the horizontal axis; spiracular plate with three very broad slits pointed at the base---------- No. 17, **Sarcophaga aculeata** Aldrich.
19. Spiracular plate with a tuberculate projection on the inner edge; plate rounded with three curved slits--- No. 18, **Sarcophaga singularis** Aldrich.
Spiracular plates not as above---------- 20
20. Spiracular plates with a small narrow ridge in addition to the main lobes---------- 21
Spiracular plates without the above ridge---------- 22

21. Spiracular plates with a narrow ridge on the lower inner edge; slits long, narrow; the inner slit with a bend just above the middle.
No. 19, **Sarcophaga haemorrhoidalis** Fallén.
Spiracular plate with a narrow ridge between the two inner slits; slits of nearly equal length, broad_ No. 20, **Chaetoravinia quadrisetosa** Coquillett.
22. Anal opening located on a definite tubercle; spiracular slits short, slightly curved; plate with an extended edge along the upper and outer edges.
No. 21, **Sarcophaga rudis** Aldrich.
Anal opening not as above____ 23
23. Spiracular plates rounded, lobes flattened with three straight slits of equal length____________________ No. 22, **Sarcophaga pachyprocta** Parker.
Spiracular plates not flattened_____________________________________ 24
24. Spiracular plate with the first slit bent sharply downward to the right_ 25
Spiracular plate not as above_______________________________________ 26
25. Spiracular plate with the middle slit quite long; posterior cavity large.
No. 23, **Sarcophaga barbata** Thomson.
Spiracular plate with the middle slit short, posterior cavity small.
No. 24, **Sarcophaga bisetosa** Parker.
26. Posterior cavity round or nearly so_________________________________ 27
Posterior cavity elliptical____ 28
27. Spiracular plate with an oblique point on the first lobe.
No. 25, **Sarcophaga plinthopyga** Wiedemann.
Spiracular plate without the above point; spiracular plate more quadrate; lobes broad________________________ No. 26, **Helicobia helicis** Townsend.
28. Spiracular plate with the first slit much longer than the second or third.
No. 27, **Sarcophaga uliginosa** Kramer.
Spiracular plate not as above_______________________________________ 29
29. Lobes of plate broad; slits short and broad; posterior cavity on but below the horizontal axis; lower edge of cavity with short rugosities.
No. 28, **Sarcophaga davidsoni** Coquillett.
Lobes not as above____ 30
30. Spiracular slits short____ 31
Spiracular slits long____ 32
31. Spiracular plate rounded; slits slightly bent; posterior cavity not elliptical; no indication of segmentation on the posterior end of pupa.
No. 29, **Sarcophaga prohibita** Aldrich.
Spiracular plate more rectangular; first slit slightly curved, with the other two slits parallel; posterior cavity elliptical; one segmental line prominent on the posterior end of the puparium.
No. 30, **Sarcophaga morosa** Aldrich.
32. First two slits longer than the third________________________________ 33
All slits of about equal length______________________________________ 34
33. All three slits slightly arcuate; a conical tubercle on each side of anal opening_________________________ No. 31, **Sarcophaga latisterna** Parker.
First two slits slightly arcuate; third slit quite short and straight.
No. 32, **Sarcophaga marginata** Aldrich.
34. Puparium with indications of segmentation on the posterior end; first slit slightly sinuous; a tubercle on each side of the anal opening.
No. 33, **Sarcophaga bullata** Parker.
Puparium smooth ____ 35

35. Puparium with a depression, containing a central ridge above the posterior cavity; posterior cavity small, rounded; a weak tubercle each side of the anal opening; first slit bent toward the second, other slits nearly straight, of equal length---------------------- No. 34, **Sarcophaga utilis** Aldrich.
    Puparium not as above-- 36
36. Posterior cavity located on but mostly below the horizontal axis------- 37
    Posterior cavity located more centrally on the horizontal axis--------- 38
37. Spiracular plate somewhat rounded; three long, narrow, arcuated slits of equal length; a small tubercle each side of anal opening; these tubercles close together------------- No. 35, **Sarcophaga tryoni** Johnston and Teig.
    Spiracular plate not so rounded; third slit shorter than first two; larger tubercle each side of anal opening; these tubercles widely separated.
    No. 36, **Sarcophaga dux** Thomson.
38. With large rounded tubercles each side of anal opening; slits in spiracular plate narrow, slightly arcuate and of nearly equal length.
    No. 37, **Sarcophaga aldrichi** Parker.
    Tubercles at anal opening very small or absent--------------------- 39
39. Tubercle small-- 40
    Tubercles absent; spiracular plate with an extension of chitin except on the inner edge; first two slits parallel; third slit slightly arcuate and extending below the other silts------- No. 38. **Sarcophaga kellyi** Aldrich.
40. Middle slit long, straight--- 41
    All three slits slightly arcuate; posterior cavity elongated transversely; ridges on spiracular plate broad, with a deep notch between them.
    No. 39, **Ravinia peniculata** Parker.
41. Spiracular plate rounded; tubercles and anal opening near lower edge of posterior cavity-------------------- No. 40, **Sarcophaga placida** Aldrich.
    Spiracular plate more rectangular; tubercles more widely separated; more distant from posterior cavity and with a slightly raised area between them----------------------------- No. 41, **Sarcophaga froggatti** Taylor.

TABLE OF SPECIES—LARVAE

1. Anterior end pointed; posterior end truncate; chitinous spines small--- 2
   Anterior and posterior ends tapering slightly; chitinous spines very robust.
   No. 42, **Sarcophaga cistudinis** Aldrich.
2. Larva quite robust; posterior cavity small; a large rounded tubercle each side of the anal opening; spines along segmental lines small and sparse.
   No. 43, **Wohlfahrtia vigil** Walker.
   Larva more slender; posterior cavity larger---------------------------- 3
3. Posterior cavity with a very large tubercle each side; anal tubercles very widely separated; spiracular plates small; chitinous edge of plate broad and the slits short------------------ No. 44, **Sarcophaga placida** Aldrich.
   Posterior cavity and characters not as above------------------------- 4
4. Anal tubercles slender; tubercles below posterior cavity nearly in a line; spiracular plates large with long slits.
   No. 45, **Sarcophaga bullata** Parker.
   Anal tubercles more robust; tubercles below posterior cavity, with a pair of small ones below the usual line; spiracular plates smaller.
   No. 46, **Sarcophaga securifera** Villeneuve.

DESCRIPTIONS OF THE PUPARIA

1. SARCOPHAGA CISTUDINIS Aldrich

Medium sized, dull, deep reddish black, very rugose with the segmentation distinct. Posterior cavity distinct but not deep; it is elliptical and located centrally on the horizontal axis; no tubercles on the edge of the posterior cavity. Each spiracular plate is smooth, shining, reddish-black with three dark, dull yellow slits; there are no indications of ridges around the slits; the slits are straight and converge slightly at their bases; each spiracular plate is on a slight elevation which is rugose. Anal opening is a distinct depression in the middle of a large wrinkle just below the posterior cavity. Anterior spiracles are missing in this material.

Length, 10 mm.; diameter, 3.5 mm.

Long Branch, N. J., no date. In collection of J. Bequaert and National Collection. Reared from box turtle *Cistudo carolina.*

2. SARCOPHAGA COMMUNIS, var. OCHRACEA Aldrich

Large sized, dull, reddish black, decided transversely wrinkled. Posterior cavity deep, broadly elliptical; located on but mostly above the horizontal axis; a depression above (seen from lateral view) and deeply notched laterally; numerous broad, flattened, yellowish tubercles around the entire edge of the cavity. Each spiracular plate is subshining, deep reddish with three long, reddish yellow slits; first slit bent outward; middle slits decidedly converging toward the apex; spiracular plates separated by a space equal to one-half the width of one plate. Anal opening small and not very conspicuous and located not far below the cavity. Anterior end of puparium decidedly wrinkled; first three segments very well marked and a broad lateral ridge. Anterior spiracles located at the apex of the puparium; spiracles are about two and one-half to three times as long as high, with 22 small, deep yellow lobes; basal portion of the spiracle is deep reddish.

Length, 8–9.5 mm.; diameter, 3.5–4 mm.

Dallas, Texas, August 28, 1907, to September 10, 1907; F. C. Pratt, collector. Reared from cow dung.

3. SARCOPHAGA COMMUNIS Parker

Medium sized, dull, dark red. Posterior cavity medium sized, not very deep, elliptical, located on but mostly below the horizontal axis; on each side of the vertical center line, above the cavity, are three blackish pointed tubercles; below the cavity, on each side, is a small roughened area. Each spiracular plate is dull, dark red

with the three lobes well defined apically; three yellow slits, shining; middle slits nearly parallel, or at most converging slightly toward the apex; spiracular plates separated by a space equal to half the width of one plate. Anal opening small, slightly depressed, located a short distance below the edge of the cavity; no anal tubercles. Anterior spiracles much wider than high, located a short distance below the apex of the puparium; each spiracle has 18 small yellow lobes; lower portion of spiracle is deep, dull red.

Length, 7.5 mm.; diameter, 2.75–3 mm.

Dallas Texas, August 13, 1907; F. C. Pratt collector. Scavenger. Also found in human excrement.

4. SARCOPHAGA SECURIFERA Villeneuve

Large, dull, dark red. Posterior cavity deep, large, elliptical, located mostly above the horizontal axis; tubercles around the edge of the cavity distinct; deeply incised in lateral view. Each spiracular plate is shining black with three long, narrow, yellow slits; the middle slits are parallel; at the lower inside edge of each spiracular plate is a raised, roughened area; spiracular plates separated by a space equal to about half the width of one plate. From the lower edge of the cavity is a narrow, sinuous, keel-like ridge extending to the anal opening; a row of very short setae the entire length of this ridge; each side of the anal opening is a conical tubercle and the two are connected by a roughened raised area. Anterior spiracles arcuate, about twice as wide as high and having 10 small yellow lobes; reddish brown near the base.

Length, 9–11 mm.; diameter, 3–4 mm.

Washington, D. C., June 8, 1923; H. E. Ewing, collector. Reared from decomposed liver.

5. SARCOPHAGA COOLEYI Parker

Large, dull, dark red. Posterior cavity medium sized, elliptical, deep, and located on horizontal axis; two tubercles on each side of cavity flattened; from the lower edge of the cavity and connected with the anal tubercles is a broad rounded ridge which forks and connects the two anal tubercles. Each spiracular plate is black, subshining; each plate has three yellow slits, the middle ones parallel. Spiracular plates separated by a space about half the width of one plate. Anal opening located between the two anal tubercles. Anterior spiracles slightly more than twice as broad as high and having 16 yellow lobes; spiracle reddish brown near base. Spiracles located at the end of the puparium.

Length, 10 mm.; diameter, 4 mm.

Laurel, Montana, 1914. Reared from decayed fish.

6. AGRIA AFFINIS Fallén

Medium to large sized. Dull, yellowish red to a deep red, nearly black; from a lateral view there is a small depression above the posterior cavity. Posterior cavity large, deep, rounded, located centrally on the horizontal axis; tubercles on edge of cavity indistinct. Each spiracular plate is small, shining, from dark red to black; each plate has three reddish slits of nearly equal length converging very slightly toward their basal ends; spiracular plates separated by a space nearly equal to the width of one plate. Anal opening distinct, with a rounded tubercle on each side; this tubercle varies somewhat in size. There are indications of an indistinct ridge from the anal opening to the lower edge of the cavity. Anterior spiracles are missing in this material.

Length, 6–9 mm.; diameter, 2.5–3.75 mm.

Melrose Highlands, Massachusetts (Gipsy Moth Laboratory). In national collection and one specimen in collection of R. R. Parker. Reared from larva of *Vanessa antiopa.*

7. SARCOPHAGA ELEODIS Aldrich

Medium sized, dull, dark, yellowish red. Posterior cavity small, nearly round, located entirely below the longitudinal axis; this location is a little variable; tubercles indistinct or absent. Each spiracular plate is very dark, shining red, with three narrow, yellow slits; first slit slightly bent below the middle; middle slits parallel; on the outside of each plate is a narrow extended area of a dark reddish-black color; spiracular plates separated by a space nearly equal to the width of one plate. Anal opening not very distinct and located near the edge of the cavity; no anal tubercles. Anterior spiracles slightly below the apex of the puparium; each spiracle has seven yellow lobes; area on the side reddish brown down to the base.

Length, 8 mm.; diameter, 3 mm.

Maxwell, New Mexico; D. J. Caffrey, collector. Koehler, New Mexico; V. L. Wildermuth, collector. Reared from *Eleodes extricata*, *E. fusiformis*, *E. hispilabris*, *E. obsoleta*, *E. tricostata*, and *Asida obvata.*

8. SARCOPHAGA OPIFERA Coquillett

Small, dull, yellowish to red. Posterior cavity small, elliptical, located above the horizontal axis; no tubercules visible around the edge. Each spiracular plate is shining, deep reddish with three yellow slits; middle slits nearly parallel; spiracular plates separated by a space less than the width of one plate. Anal opening small, depressed, located close, under the posterior cavity; no anal tubercules.

Anterior spiracles located near the apex of the puparium; each spiracle has six yellow lobes well separated; basal portion of the spiracle is dull, dark red.

Length, 5–6 mm.; diameter, 1.5–2 mm.

Natrona, California, July 18, 1885. Reared from *Melanoplus devastator*, *marginates*, *differentialis*, *plumbeus*, and *bivittatus*.

9. SARCOPHAGA SUBAENESCENS Aldrich

Small, dull, yellowish red. Posterior cavity small, round, located centrally on the horizontal axis; the edge of the cavity flattened and there are no indications of tubercules. Each spiracular plate is shining, deep red with three yellow slits, each on a broad lobe, the middle slit is straight and the other two slits converge toward it at the lower end; spiracular plates separated by a space about three-fourths the width of one plate. Anal opening small, fairly distinct, and located just below the posterior cavity. Anterior spiracles are missing.

Length, 4.5 mm.; diameter, 2 mm.

Somerville, New Jersey, June 23, 1922; R. T. Webber, collector. From spider web.

10. SARCOPHAGA HUNTERI Hough

Small, dull yellowish red. Posterior cavity is quite small, elliptical, and located on the horizontal axis; no tubercles visible on the edge of the cavity. Each spiracular plate is sub-shining, dark red with three distinct lobes; three yellow slits each slightly broader at the base and pointed at the apex; middle slits almost parallel; spiracular plates almost touching. Anal opening quite small, depressed, and located just below the edge of the cavity; no anal tubercle. Anterior spiracles nearly as high as broad; each spiracle has nine small yellow lobes; basal part of spiracle is deep reddish.

Length, 5.25 mm.; diameter, 2 mm.

Charleston, Missouri, September 28, 1914; G. W. Barber, collector; Platte, South Dakota, C. N. Ainslie, collector. Reared from *Melanoplus differentialis*, *M. atlanis*, and from codling moth.

11. SARCOPHAGA ATLANIS Aldrich

Small sized, dull, yellowish red. Posterior cavity quite small, shallow, located on the horizontal axis; no tubercles around the edge of the cavity; last two segments of puparium rather distinct. Each spiracular plate is sub-shining, red with three yellow slits; the middle slits parallel, spiracular plates separated by a space about three-fourths the width of one plate; on the inside, near the lower edge of each spiracular plate is a small, wrinkled area. Anal opening small,

inconspicuous, dark; on each side of the opening is a small, rounded depression; no anal tubercles. Anterior spiracles small, located close to the apex of the puparium; each spiracle has seven yellow lobes; spiracle dull, dark red at base.

Length, 6 mm.; diameter, 2 mm.

Aberdeen, South Dakota, July 12. Reared from *C. atlanis* and grasshoppers.

12. SARCOPHAGA FUSCICAUDA Böttcher

Large, dull, dark red. Posterior cavity deep, diameter large, located centrally on the longitudinal axis; tubercles on outer edge of cavity indistinct. Each spiracular plate is reddish black with three yellow, narrow slits, the third slit much shorter than the other two; first slit deeply curved on lower half toward the lower end of the middle slit; middle slits about parallel; spiracular plates separated by a space slightly less than the width of one plate. Anal opening some distance from the edge of the cavity; each side of the anal opening is a conical tubercle, these tubercles are widely separated. Posterior end of puparium shows two segments slightly more pronounced than the others. Anterior spiracles close to anterior end of puparium; each spiracle has 27 small, yellow lobes, five of these are below the edge and on the outside surface of the spiracle; basal part of the spiracle reddish-brown.

Length, 9 mm.; diameter, 3.5 mm.

Honolulu, J. F. Illingworth, collector; two specimens in national collection. Honolulu, February 5, 1917; Timberlake, collector; in collection of R. R. Parker. Reared from dead grubs.

13. SARCOPHAGA STERNODONTUS Townsend

Medium sized, sub-shining, dark red; more shining around the posterior cavity. Posterior cavity deep, large, rounded, more pointed at lower middle; at the lower edge of the posterior cavity is a short, sharply defined carina or ridge. Each spiracular plate is very deep red, subshining with three reddish yellow slits; middle slits about parallel; on the upper and outside edge of each spiracular plate is a broad extension, slightly broader toward the apex; spiracular plates separated by a space equal to about two-thirds the width of one plate. Anal opening depressed, some distance from the edge of the cavity; each side of the anal opening is a small conical tubercle; these tubercles separated by a space equal to about twice the height of one tubercle. Anterior spiracles about as high as broad, not far from anterior end of puparium; each spiracle has 14 small yellow lobes, otherwise the spiracle is a dull, very dark red.

Length, 7 mm.; diameter, 2.5 mm.

Canal Zone, September 1, 1918; H. F. Dietz, collector, Mayaguez, Porto Rico, November 17, 1915; R. H. Van Zwalenburg, collector. Reared from pupa of *Erinnyis allo* Linnaeus.

14. SARCOPHAGA AUSTRALIS Aldrich

Medium sized, dull, yellowish red. Posterior cavity large, deep, slightly wider than high; located about centrally on the horizontal axis; upper edge of cavity has three tubercles on each side, the middle one smaller; on lower edge are four tubercles, the middle pair being larger. Each spiracular plate is black, subshining with three yellow slits, the middle slits are parallel; spiracular plates are separated by a space slightly less than the width of one plate. Anal opening small, some distance from the edge of the cavity; each side of the anal opening is a distinct, conical tubercle; these tubercles are separated by a space equal to the height of one tubercle. Anterior spiracles are missing in the specimen.

Length, 7 mm.; diameter, 2 mm.

Baton Rouge, Louisiana, December 8, 1923; T. H. Jones, collector.

15. SARCOPHAGA SARRACENIOIDES Aldrich

Medium to large sized, dull, dark red. Posterior cavity on but mostly below the horizontal axis; numerous distinct wrinkles on the edge of the cavity. Each spiracular plate is shining reddish black with yellow slits; middle slits slightly converging toward the apex; spiracular plates separated by a space equal to about half the width of one plate. Anal opening located some distance below the edge of the cavity; each side is a definite, rugose, conical tubercle; these tubercles are separated by a space equal to about one and one-half times the height of one tubercle. Anterior spiracles located a short distance from the apex of the puparium; each spiracle has 18 yellow lobes; area in center of this spiracle is reddish and rugose.

Length, 7–10 mm.; diameter, 3–3.75 mm.

Gainesville, Texas; W. E. Pennington, collector, Webster, No. 12745. Gila River Valley, Arizona, August 21, 1915; R. N. Wilson, collector. Baton Rouge, Louisiana, April 5; T. H. Jones, collector. Dallas, Texas, July 15, 1905; W. D. Pierce, collector. Okanogan Valley, British Columbia (from *Anabrus*); emerged April, 1896; J. Fletcher. Graysville, Tennessee, from *Dynastes tityus*.

16. WOHLFAHRTIA VIGIL Walker

Large, dull, very dark red. Posterior cavity small, elliptical, located centrally on the horizontal axis; edge of cavity broadly rounded; tubercles on edge rather weak. Each spiracular plate is subshining, blackish with three yellow slits, first two slits bent near

their base toward the third slit, which is straight; middle slits parallel; spiracular plates are separated by a space about half the width of one plate. Below the posterior cavity is a rounded area in the middle of which is the anal opening; each side of the anal opening is a distinct rounded tubercle, the space between these tubercles is about the width of one tubercle at its base. Anterior spiracles near the apex of the puparium; each spiracle has nine lobes in a slightly curved line.

Length, 9 mm.; diameter, 3.5 mm.

Ithaca, New York; emerged July 15, 1922; R. C. Shannon. Reared from rabbit caught by R. Harwood.

17. SARCOPHAGA ACULEATA Aldrich

Large sized, dull, yellowish red to dark red. Posterior cavity not very deep, small, elliptical, located just above the horizontal axis; tubercles on the edge of the cavity indistinct; on the dorsum above the cavity is a faint depression (seen from lateral view). Each spiracular plate is shining, deep red with three large, yellow slits pointed at the posterior end; middle slits are almost parallel; spiracular plates are separated by a space equal to about one-third the width of one plate. Anal opening small, darkened, and faintly depressed; no anal tubercles; between the anus and the cavity is a large depression, sometimes this depression appears more like two depressions with a faint elevation between them; below the anus is a depression or fold reaching up on each side nearly to the horizontal axis. Anterior spiracles located near to the apex of the puparium; each spiracle has five yellow lobes; basal portion of spiracle is dull reddish.

Length 8–8.5 mm.; diameter, 2.75–3 mm.

Reared from an Acridid species at Alpine, California; C. M. Packard, collector. Pasadena No. 16163, July 21, 1916. Ashland, Nebraska, August 14, 1914, from grasshopper; W. E. Pennington, collector; exp., No. *A* 787. Ellis, Kansas, no date; from *E. opaca;* J. S. Wade, collector; Webster, No. 14258.

18. SPIROBOLOMYIA SINGULARIS Aldrich

Medium to large sized; dull yellowish to red. Posterior cavity deep, broadly elliptical, located about centrally on the horizontal axis; tubercles around the edge of the cavity indistinct; on the dorsal part of the puparium, close to the cavity is a faint depression. Each spiracular plate dull, reddish to black, with three narrow yellow slits, the two middle slits very slightly converging toward the apex; on the inner edge of the spiracular plate, near the base, is a slight projection; spiracular plates separated by a space about equal to

half the width of one plate. Anal opening small, dark, depressed, located some distance below the edge of the posterior cavity; each side of the anal opening is a small tubercle; these tubercles are separated by a space about equal to twice the height of one tubercle. Anterior spiracles are missing in these specimens.

Length, 6.5–8 mm.; diameter, 2.5–3 mm.

Enola, Virginia, May 1, 1915; Sara Reynolds, collector.

19. SARCOPHAGA HAEMORRHOIDALIS Fallén

Large, dull, brownish red. Posterior cavity deep, nearly round, the greatest width being on the horizontal; located centrally on the horizontal axis; there are two pairs of rounded tubercles above the center line and one pair below. Each spiracular plate is dark red subshining, with three narrow, yellowish slits, the first or inner slit is bent slightly just above the middle; on the inner edge of each plate, near the base, is a small ridge; spiracular plates separated by a space about half the width of one plate. Anal opening distinct, located a short distance below the cavity. Anterior spiracles close to the apex, much wider than high, with 14 small yellow lobes: the basal portion of the spiracle deep red.

Length, 9–10 mm.; diameter, 2.5–4 mm.

No date or locality given; specimens in collection of R. R. Parker; two specimens in national collection.

20. CHAETORAVINIA QUADRISETOSA Coquillett

Small, dull, yellowish red. Posterior cavity is of medium size, elliptical, and located centrally on the horizontal axis: tubercles around the edge of the cavity fairly distinct. Each spiracular plate is subshining, deep red, with three yellow slits; middle slits are about parallel and longer than either of the other two; between the first and second slits is a faint, narrow, elongated ridge; spiracular plates separated by a space equal to about one-third the width of one plate. Anal opening depressed, located some distance below the edge of the cavity, slightly darkened near the outer edges; no anal tubercles. Anterior spiracles at apex, wider than high; each spiracle has 13 yellow lobes, lower portion of spiracle is deep reddish.

Length, 5.5 mm.; diameter, 2 mm.

Victoria, Texas, June 15, 1907; J. D. Mitchell, collector; bred from manure; Hunter, No. 1611–39. Dallas, Tex., August 10, 1907, bred from manure; F. C. Pratt, collector; Hunter, No. 1611–11.

21. SARCOPHAGA RUDIS Aldrich

Small sized, dull, dark red. Posterior cavity fairly deep, elliptical, located on but entirely above the horizontal axis; immediately

above the cavity is a slight depression (seen laterally). Each spiracular plate with three distinct lobes, shining, very dark, red, with three yellow slits; middle slits about parallel; spiracular plates separated by a space at least as wide as the width of one plate; each spiracular plate has an extension along the upper and outer edges. Anal opening conspicuous, depressed, with an elevated ridge encircling it, located close to under edge of the cavity; no anal tubercles. Anterior spiracles missing in this material.

Length, 6 mm.; diameter, 2 mm.

Charleston, Missouri, June 22, 1915; E. H. Gibson, collector. Reared from *L. gibbosus*. Webster No. 13668.

22. METOPOSARCOPHAGA PACHYPROCTA Parker

Medium sized, dull to subshining, yellowish red to dark red. Posterior cavity deep, somewhat quadrate, medium sized, located on the horizontal axis; tubercles around the edge of the cavity indistinct; laterally the posterior end is deep notched. Each spiracular plate is dull, deep red with three narrow, yellow slits, the first and middle one parallel; middle slits nearly parallel; at the lower, inner edge of the spiracular plate is a small wrinkle. Anal opening and a wrinkle on each side well defined and darkened; no anal tubercles. Anterior spiracles at the apex of the puparium, a little wider than high; each spiracle has 11 yellow lobes; basal portion of spiracle dark reddish.

Length, 7 mm.; diameter, 2.5 mm.

Beaufort, North Carolina, from terrapin eggs; issued September 27, 1915; W. P. Hay, collector.

23. SARCOPHAGA BARBATA Thomson

Large, dull, dark red, dorsal surface definitely arched. Posterior end reduced in diameter with an elliptical, deep, transverse cavity located nearly centrally; tubercles very faintly showing; each side of and below the cavity is a good sized, faint depression. Each spiracular plate has three narrow slits of unequal length; the first slit is sharply bent near its lowest third and directed toward the lower end of the middle slit; spiracular plates separated by a space equal to about half the width of one plate; middle slits very slightly oblique, converging toward their apex. Anal opening depressed, some distance below the cavity; each side of anal opening is a very small, conical tubercle; these tubercles are separated by a space equal to one and one-half times the height of one tubercle. Anterior spiracles are located close to the apex of the puparium; each spiracle has 12 small, yellow lobes; lower area of the spiracle dark reddish brown.

Length, 9.5 mm.; diameter, 4 mm.

Honolulu, Hawaii, March 27, 1917; P. H. Timberlake, collector. Reared from dead grubs; Timberlake, No. 7629.

24. SARCOPHAGA BISETOSA Parker

Small sized, dull, dark red. Posterior cavity small, deep, somewhat elliptical, with the lower edge notched in the middle; located centrally on the horizontal axis; tubercles or the edge of the cavity indistinct. Each spiracular plate is subshining, black with three yellowish slits each on a well-defined ridge; the first slit is slightly bent, near its base, toward the second; the plate is slightly extended beyond the ridges along the upper and outer edge; spiracular plates are separated by a very narrow space. Anal opening small, located just below the posterior cavity; there is a small tubercle each side of the anal opening. Anterior spiracles close to the apex; each spiracle has 29 small, yellow lobes; the lower part of the spiracle is deep red.

Length, 7 mm.; diameter, 2 mm.

Rockville, Pennsylvania, April 17, 1922; A. B. Champlain, collector.

25. SARCOPHAGA PLINTHOPYGA Wiedemann

Large sized, dull, dark red with a faint depression above the posterior cavity. Posterior cavity medium to large sized, rounded and located centrally on the horizontal axis; tubercles on edge of cavity fairly well marked. Each spiracular plate is shining reddish black with three yellow slits; middle slit long and straight; first slit is slightly sinuous and the first ridge has a point on the side near the apex; spiracular plates separated by a space equal to about one-third of the width of one plate. Anal opening depressed and some distance below the edge of the cavity; a rounded tubercle on each side of the anal opening. Anterior spiracles are missing in this material.

In one specimen the spiracular plates are nearly touching.

Length, 7–9 mm.; diameter, 2.5–3.75 mm.

Victoria, Texas, November 1, 1916; J. D. Mitchell, collector; Bishopp, No. 7092.

26. HELICOBIA HELICIS Townsend

Small sized, dull, dark red. Posterior cavity large, deep, rounded, located centrally on the horizontal axis; tubercles around the edge indistinct; above the posterior cavity is a depression (seen from lateral view). Each spiracular plate is small, shining, reddish black with three narrow yellow slits; middle slits about parallel; spiracular plates separated by a space slightly greater than the width of one plate. Anal opening large, not far below the cavity; no anal

tubercles. Anterior spiracles located close to the apex of the puparium; each spiracle is wider than high and with 12 yellow lobes; basal portion is dark reddish.

Length, 5–6 mm.; diameter, 1.5–2 mm.

Chain Bridge, District of Columbia. Reared August 17, 1912, from *Allorrhina nitida;* C. T. Greene, collector.

27. SARCOPHAGA ULIGINOSA Kramer

Medium sized, dull, dark red. Posterior cavity medium sized, elliptical, located centrally on the horizontal axis; three indistinct tubercles on each side of the cavity above the center line. Each spiracular plate is shining dark red with three yellow, narrow slits; middle slit straight; the first or inner slit parallel with the second for the first half of its length and then the first slit bends diagonally toward the second and reaches a little beyond it; outer slit almost as long as the middle one; spiracular plates separated by a space equal to about one-third the width of one plate. Anal opening located in a transverse depression a short distance below the cavity. Anterior spiracles close to the apex; each spiracle has 30 small, yellow lobes, with the central portion of the spiracle deep reddish.

Length, 8 mm.; diameter, 3 mm.

Gipsy Moth Laboratory, 548B; May 14, 1907. In collection of R. R. Parker.

28. SARCOPHAGA DAVIDSONI Coquillett

Medium sized, dull, yellowish red. Posterior cavity nearly round below, but touching the horizontal axis; tubercles on edge not visible; there are a few, short, visible wrinkles on the lower edge of the cavity. Each spiracular plate shining, dark red, with three yellow slits and the lobes distinct; middle slits nearly parallel; spiracular plates separated by a space slightly greater than the width of one plate. Anal opening small, depressed, with a darkened area around the edge, located some distance below posterior cavity; no anal tubercles. Anterior spiracle located below the anterior end of the puparium; each spiracle has six small, yellow lobes; basal portion of spiracle is deep reddish.

Length, 6 mm.; diameter, 2.5 mm.

Los Angeles, California. Reared from eggs of *Epeira argentata*, September, 1893; Anstruther Davidson, collector.

29. SARCOPHAGA PROHIBITA Aldrich

Medium sized, dull, reddish brown. Posterior cavity small, deep, somewhat hexagonal, located on but mostly below the horizontal axis; tubercles on the edge indistinct. Each spiracular plate shining, deep red with three yellow slits; middle slits about parallel;

spiracular plates separated by a space equal to the width of one plate. Anal opening small, inconspicuous, and with a depressed area on each side. No anal tubercles. Anterior spiracles missing in this material.

Length, 7 mm.; diameter, 2.5 mm.

Manhattan, Kansas, June 5, 1917; McColloch and Hays, collectors; Lafayette cage 611*a*.

30. SARCOPHAGA MOROSA Aldrich

Large sized, dull, very dark red. Posterior cavity deep. Medium sized, elliptical, located centrally on the horizontal axis; tubercles on edge of cavity not very distinct. Each spiracular plate is subshining, black with three yellow slits; the middle and third slit about parallel; the first slit is slightly curved downward and toward the middle slit; spiracular plates separated by a space equal to about half the width of one plate. Anal opening small, distinct, located just a short distance below the edge of the cavity; each side of the anal opening is a well-defined tubercle with a large reddish spot on the inner side. Anterior spiracles are missing.

Length, 9.5 mm; diameter, 4 mm.

Near Ottawa, Canada; F. Johansen, collector. Reared July 11, 1918, by C. T. Greene.

31. SARCOPHAGA LATISTERNA Parker

Large sized, dull, reddish black. Posterior cavity deep, elliptical, located centrally on the horizontal axis; two tubercles on the upper edge of the cavity faintly visible, the others indistinct; laterally the posterior end of the puparium is slightly notched. Each spiracular plate is dull, black, with three narrow yellow slits, the two outer ones closer together, middle slits about parallel; spiracular plates separated by a space equal to half the width of one plate. Anal opening small, distinct, depressed, with a low, rounded tubercle on each side; tubercles separated by a space equal to about one and one-half times the diameter of one tubercle. Anterior spiracles are missing in this material.

Length, 9.5 mm.; diameter, 4 mm.

Andover, New Hampshire, Gipsy Moth Laboratory, 10041б–7, August 2, 1922.

32. SARCOPHAGA MARGINATA Aldrich

Medium sized, subshining, yellowish red, and slightly arched along the dorsum. Posterior cavity medium sized, elliptical, located centrally on the horizontal axis; no distinct tubercles on the edge of the cavity; a distinct depression on the dorsum just above the

cavity. Each spiracular plate is shining red, with three yellow slits; inner and middle slit slightly convex to each other and of about equal length; outer slit straight and about two-thirds as long as the middle one; spiracular plates separated by a space about as wide as one plate. Anal opening small, indistinct, located just below the cavity. Anterior spiracles are missing in the specimens at hand.

Length, 7–7.5 mm.; diameter, 3 mm.

One specimen without labels; other specimen labeled "Sarcophaga No. 25." Both specimens in collection of R. R. Parker.

33. SARCOPHAGA BULLATA Parker

Large, dull, dark red. Posterior cavity large, elliptical; located centrally on the horizontal axis; tubercles around the edge very small; two posterior segments slightly visible; on each side and below the posterior cavity is an area faintly depressed. Each spiracular plate is shining black with three narrow yellow slits; the first slit is slightly sinuous; middle slits about parallel; spiracular plates separated by a space about half the width of one plate. Anal opening some distance from the edge of the cavity; each side of the anal opening is a conical tubercle; these tubercles are separated by a space about twice the height of one tubercle. Anterior spiracles arcuate, about twice as wide as high; located at the apex each spiracle has 20 small, yellow, lobes; spiracle reddish brown at the base.

Length. 8 mm.; diameter, 3 mm.

Bethesda, Maryland, June 26, 1915; reared from meat by Max Kisliuk; Hunter, No. 3281.

34. SARCOPHAGA UTILIS Aldrich

Large subshining, dark red; surface around the posterior cavity shining with the edge of the cavity yellow. On the dorsum at the posterior end is a depression with a broad ridge in the middle. Posterior cavity nearly round, located centrally on the horizontal axis. Each spiracular plate is shining, deep reddish black, with three yellow slits of nearly equal length; two inner slits parallel with the outer or first slit bent slightly to the right near the base; spiracular plates separated by a space equal to about two-thirds the width of one plate. Anal opening small, fairly distinct, with a rather weak tubercle on each side of the opening. Anterior spiracles about as high as wide; each spiracle has 26 small yellow lobes with the lower part of the spiracle deep red.

Length, 9 mm.; diameter, 4 mm.

Natrona, Pennsylvania, May 30, 1896. In collection of R. R. Parker.

35. SARCOPHAGA TRYONI Johnston and Teig

Small sized, dull, from light yellowish-red to dark red. Posterior cavity medium sized, elliptical, located entirely below with just the upper edge touching the horizontal axis; tubercles on the edge of the cavity distinct, somewhat flattened laterally; there are three pairs on the upper half of the cavity and two pairs on the lower half. Below the cavity is a narrow ridge reaching from the lower edge of the cavity to the anal opening. Each spiracular plate is shining, deep reddish black, and with three narrow yellow slits slightly curved, the first two slits convex to one another; spiracular plates are just barely separated at the upper, inner edge. Anal opening small, depressed, with a small, conical tubercle on each side. Anterior spiracles each have 23 small, yellow lobes with the basal portion of the spiracle deep red.

Length, 6.5 mm.; diameter, 2.5 mm.

One specimen labeled "1501," one specimen without labels. Both in collection of R. R. Parker.

36. SARCOPHAGA DUX Thomson

Large sized, dull, dark red. Posterior cavity large, deep, elliptical; located on but mostly below the horizontal axis; tubercles on the edge of the cavity indistinct; laterally the cavity is deeply notched. Each spiracular plate is subshining, reddish black, with three well-defined lobes and three yellow slits, first two slits much longer than the third; first two slits converge toward the base and almost touch; spiracular plates separated by a space equal to about half the width of one plate. At the lower edge of the cavity, in the center, is a very short, narrow carina. Anal opening some distance below the cavity, short, depressed; each side is a tubercle slightly longer than its diameter; these tubercles are separated by a space equal to about three and one-half times the length of one tubercle. Anterior spiracles missing in this material.

Length, 9 mm.; diameter, 3.25 mm.

Honolulu, February 5, 1917. Reared from dead grubs; P. H. Timberlake, collector.

37. SARCOPHAGA ALDRICHI Parker

Large, dull, red to black. Posterity cavity deep, medium-sized, located centrally on the horizontal axis; edges of cavity slightly wrinkled. Each spiracular plate is blackish, subshining and with three narrow yellow slits; between the first and second slit is a short yellow line which resembles a short slit; spiracular plates separated by a space equal to about one half the width of one plate. Anal opening distinct, located a short distance below the cavity; each

side of the anal opening is a large, rounded tubercle. Anterior spiracles close to the apex; each spiracle has about 80 small, yellow lobes; base of spiracle is deep reddish.

Length, 8–9.5 mm.; diameter, 3–4 mm.

Lunenburg, Mass., 6114; R. T. Webber, collector. In collection of R. R. Parker. One specimen from Melrose Highlands, Massachusetts, May 25, 1916; R. T. Webber, collector. In National Collection.

38. SARCOPHAGA KELLYI Aldrich

Medium size, dull, dark red. Posterior cavity nearly round, large, located centrally on the horizontal axis; tubercles on the outside edge indistinct. Each spiracular plate is deep reddish black with three yellow, narrow slits; middle slits about parallel; each plate has an extension nearly all the way around it and a wrinkled area on the lower, inner edge; spiracular plates separated by a space about equal to the width of one plate. Anal opening small, depressed and located a short distance below the posterior cavity; no anal tubercles; on each side of the anal opening and between that opening and the posterior cavity is a depressed area. Anterior spiracles close to the anterior end of the puparium; each spiracle has six small, yellow lobes; basal portion of the spiracle is reddish brown.

Length, 8 mm.; diameter, 2.5 mm.

Gila River Valley, Arizona, August 21, 1913; R. N. Wilson, collector; Webster, No. 10535. Specimen from Minot, North Dakota, August 1919; C. N. Ainslie, collector; Sioux City, No. 19145. Elida, New Mexico; H. E. Smith, collector; Webster, No. 10244; cage 2926.

39. RAVINIA PENICULATA Parker

Small, dull, reddish-yellow. Posterior cavity, medium sized, elliptical, located centrally on the horizontal axis; tubercles on the edge of the cavity not very distinct; three pairs above and one pair below the center line; those close to the horizontal axis more distinct. Each spiracular plate reddish yellow, subshining with three yellow slits; of nearly equal length; each slit on a broad, well defined lobe; spiracular plates separated by a space from half to two-thirds of the width of one plate. Anal opening distinct, located some distance below the cavity; on each side of the anal opening is a well defined tubercle. Anterior spiracles located at the apex of the puparium; each spiracle has 10 pale yellow lobes; the lower part of spiracle is reddish.

Length, 4–5 mm.; diameter, 1.5–2 mm.

No data. Six puparia in collection of R. R. Parker; two puparia in national collection.

40. SARCOPHAGA PLACIDA Aldrich

Medium sized, dull, very dark red. Posterior cavity medium sized, slightly elliptical, located centrally on the horizontal axis; one tubercle on each side of the cavity slightly above the horizontal axis. Each spiracular plate is subshining black with three narrow yellow slits; middle slit straight, all three slits converging very slightly toward their bases; spiracular plates separated by a space nearly equal to the width of one plate. Anal opening small, depressed with a large rounded tubercle each side. Anterior spiracles at anterior end of puparium; each spiracle has 16 small, yellow lobes; basal portion dull, reddish black.

Length, 8 mm.; diameter, 3.25 mm.

Ancon, Canal Zone, September 12, 1923. Reared from *Murex;* J. Zetek, collector; "Z. No. 2305."

41. SARCOPHAGA FROGGATTI Taylor

Large, dull, very dark red. Posterior cavity small, elliptical, deep, located centrally on the horizontal axis; tubercles distinct; two pairs above the central line and one pair below: from the posterior cavity to the anal opening is a broadly rounded ridge with a tubercle on each side of the anal opening which is distinctly depressed. Each spiracular plate is shining, reddish black, with three yellow slits; the lower end of the outer slit is bent in toward the middle slit; spiracular plates separated by a space equal to about two-thirds the width of one plate. Anterior spiracles with 15 small, rounded, yellow lobes; the basal portion of the spiracle is deep red.

Length, 9–10 mm.; diameter, 3.5 mm.

Townsville, North Queensland; G. F. Hill, collector; 1506. In national collection and one specimen in collection of R. R. Parker.

DESCRIPTIONS OF THE LARVAE

42. SARCOPHAGA CISTUDINIS Aldrich

Larva pale ocher yellow, tapering slightly toward each end. There are 10 segments in addition to the head. First three segments narrow and of equal width; other segments wider and of equal width. Numerous very thick, short, pointed reddish-brown spines not confined to the segmental line but also in various other areas. Posterior cavity shallow, transversely elliptical; the edges around this cavity have very delicate, chitinous, sharp-pointed spines arranged in very short rows like the teeth of a comb; these little rows of teeth are shorter above and below the central area of the cavity. The tubercles around the posterior cavity are round, flat and appear to be made up of rounded plates located one on top of the other; these

tubercles always appear to be worn off. Each spiracular plate is located on a rounded, raised area; these areas touch each other in the center of the cavity; each plate is shining, reddish-yellow with a broad, reddish-black, wide ring around the edge very narrowly connected at the base; each plate has three broad slits nearly parallel; the first or inner slit bent slightly, in the middle, toward the second slit. Looking from the posterior end there is a large rounded, flattened tubercle like those described above. There are two mouth hooklets; two small papillae on each side of head segment near the apex; these papillae are hardly as long as their diameter. Anterior spiracles deeper reddish brown with 19 small lobes to each.

Length, 12–13 mm.; diameter, 3–4 mm.

Long Branch, New Jersey, March 29, 1910; William T. Davis, collector.

43. WOHLFAHRTIA VIGIL Walker

Larva pale yellowish white, very robust; posterior end slightly rounded, tapering to a point at the anterior end. There are 10 segments in addition to the head. First three segments slightly narrower than the others. Chitinous spines minute confined to the segmental lines, much more numerous on the anterior portion, where the spines are arranged in very short, slightly arcuated lines or groups. Anterior segments 2, 3, and 4 with large, rounded tubercles arranged transversely; posterior cavity small, deep, with six small, conical tubercles on the upper edge and with two on the lower edge. Spiracular plates small, shining, deep reddish black, with three yellow slits; the two inner slits nearly parallel. Each side of the anal opening is a large globular tubercle with the space between them about equal to the diameter of one tubercle. Between these two large tubercles is a very small tubercle. There are two mouth hooklets; two small papillae on each side of the head, brownish, the upper one is larger and darker; their length is less than their diameter. Anterior spiracles brownish, and each spiracle with nine lobes.

Length, 13 mm.; diameter, 3.5 mm.

Dunkirk, Montana, September 8, 1922; W. Roy Walker, collector. In back of Airedale puppy 6 days old.

44. SARCOPHAGA PLACIDA Aldrich

Larva yellowish white, slender, tapering to a point at the anterior end, somewhat truncate at the posterior end. There are 10 segments in addition to the head; anterior segments 2, 3, and 4 slightly narrower than the following segments, which are of about the same width. Segments 1 to 9 each have a transverse row of small conical tubercles; those of the first three segments a little more

rounded. Spines minute, pale yellow, and confined to the segmental lines. Posterior cavity deep, large, elliptical. On the edge of the upper half of the cavity is one very large conical tubercle on each side; above, between these, are two pairs of much smaller tubercles; on the lower half of the cavity are two pairs of small tubercles, with a smaller pair located centrally between them. Spiracular plate small, with three broad short slits; the chitinous edge is dark brown, very broad, extending down in a pointed fashion between the slits; the lower end of the inner edge of the plate has a deep notch, and the chitin here is more blackish. Each side of the anal opening is a large conical tubercle; these tubercles are widely separated. There are two mouth hooklets; two small papillae on each side of the head, very pale, of about equal size, their length less than their diameter. Anterior spiracles brownish yellow; each spiracle has 16 small lobes.

Length, 11 mm.; diameter, 2.5 mm.

Ancon, Canal Zone, September 12, 1923; in *Murex*. J. Zetek, collector; "Z No. 2305."

45. SARCOPHAGA BULLATA Parker

Larva pale yelowish-white tapering to a point at the anterior end. There are 10 segments in addition to the head. All segments are nearly equal in length; chitinous spines are very minute, light colored and confined to the segmental lines. Posterior cavity large, deep, elliptical. On the upper edge of the posterior cavity are three pairs of conical tubercles; the outer tubercle is slightly larger than the inner ones; the lower edge has three pairs of tubercles with the middle pair slightly smaller and located slightly below the line of the other tubercles. Spiracular plates large, faintly brownish yellow toward the apex; spiracular plates separated by a space about half as wide as the width of one plate. Each plate has three fairly wide, long yellow slits; darkened edge of the plate very narrow, widened on the lower inner edge. Below the posterior cavity the anal tubercles are nearly transverse. Anterior spiracles are brownish yellow; each spiracle has 20 small lobes.

Length, 12–13 mm.; diameter, 2.5 mm.

Washington, District of Columbia, May 31, 1923; H. E. Ewing, collector. Reared from beef liver.

46. SARCOPHAGA SECURIFERA Villeneuve

Larva is pale yellowish white, tapering gradually to a point at the anterior end. There are 10 segments of about equal width in addition to the head. The very minute chitinous points are principally along the segmental lines, but there are small similar areas between these lines; the posterior end is pretty well covered with

these small points. The three anterior segments each have a transverse row of rounded tubercles; on segments 3 to 9 there is a small granular tubercle on the lower lateral portion. Posterior cavity large, deep, elliptical, with three pairs of conical tubercles of equal size on the edge of the upper half; on the edge of the lower half are three pairs of tubercles with the middle pair smaller. Spiracular plates large, dark yelowish brown, with the edge much darker; on the lower portion of the inner edge the chitin is wider and there is also a notch on the side. Each plate has three broad slits converging at the base. Anal tubercles robust, conical, and widely separated; edge of anal opening yellowish brown. There are two mouth hooklets; two small, brownish papillae on each side of the head just barely elevated.

Length, 14–15 mm.; diameter, 3 mm.

Washington, District of Columbia, June 8, 1923; H. E. Ewing, collector. Reared from beef liver.

EXPLANATION OF PLATES

(Drawings by C. T. Greene)

Plate 1

Fig. 1. *Sarcophaga cistudinis* Aldrich.
2. *Sarcophaga communis*, var. *ochracca* Aldrich.
3. *Sarcophaga communis* Parker.
4. *Sarcophaga securifera* Villeneuve.
5. *Sarcophaga cooleyi* Parker.

Plate 2

Fig. 6. *Agria affinis* Fallén.
7. *Sarcophaga eleodes* Aldrich.
8. *Sarcophaga opifera* Coquillett.
9. *Sarcophaga subaenescens* Aldrich.
10. *Sarcophaga hunteri* Hough.

Plate 3

Fig. 11. *Sarcophaga atlanis* Aldrich.
12. *Sarcophaga fuscicauda* Böttcher.
13. *Sarcophaga sternodontis* Townsend.
14. *Sarcophaga australis* Aldrich.
15. *Sarcophaga sarracenioides* Aldrich.

Plate 4

Fig. 16. *Wohlfahrtia vigil* Walker.
17. *Sarcophaga aculeata* Aldrich.
18. *Spirobolomyia singularis* Aldrich.
19. *Sarcophaga haemorrhoidalis* Fallén.
20. *Chaetoravinia quadrisetosa* Coquillett.

Plate 5

Fig. 21. *Sarcophaga rudis* Aldrich.
22. *Metaposarcophaga pachyprocta* Parker.
23. *Sarcophaga barbata* Thomson.
24. *Sarcophaga bisetosa* Parker.
25. *Sarcophaga plinthopyga* Wiedemann.

Plate 6

Fig. 26. *Helicobia helicis* Townsend.
27. *Sarcophaga uliginosa* Kramer.
28. *Sarcophaga davidsoni* Coquillett.
29. *Sarcophaga prohibita* Aldrich.
30. *Sarcophaga morosa* Aldrich.
31. *Sarcophaga latisterna* Parker.

Plate 7

Fig. 32. *Sarcophaga marginata* Aldrich.
33. *Sarcophaga bullata* Parker.
34. *Sarcophaga utilis* Aldrich.
35. *Sarcophaga tryoni* Johnston and Teig.
36. *Sarcophaga dux* Thomson.

Plate 8

Fig. 37. *Sarcophaga aldrichi* Parker.
38. *Sarcophaga kelleyi* Aldrich.
39. *Ravinia peniculata* Parker.
40. *Sarcophaga placida* Aldrich.
41. *Sarcophaga froggatti* Taylor.

Plate 9

LARVAE

Fig. 42. *Sarcophaga cistudinis* Aldrich.
43. *Wohlfahrtia vigil* Walker.
44. *Sarcophaga placida* Aldrich.
45. *Sarcophaga bullata* Parker.
46. *Sarcophaga securifera* Villeneuve

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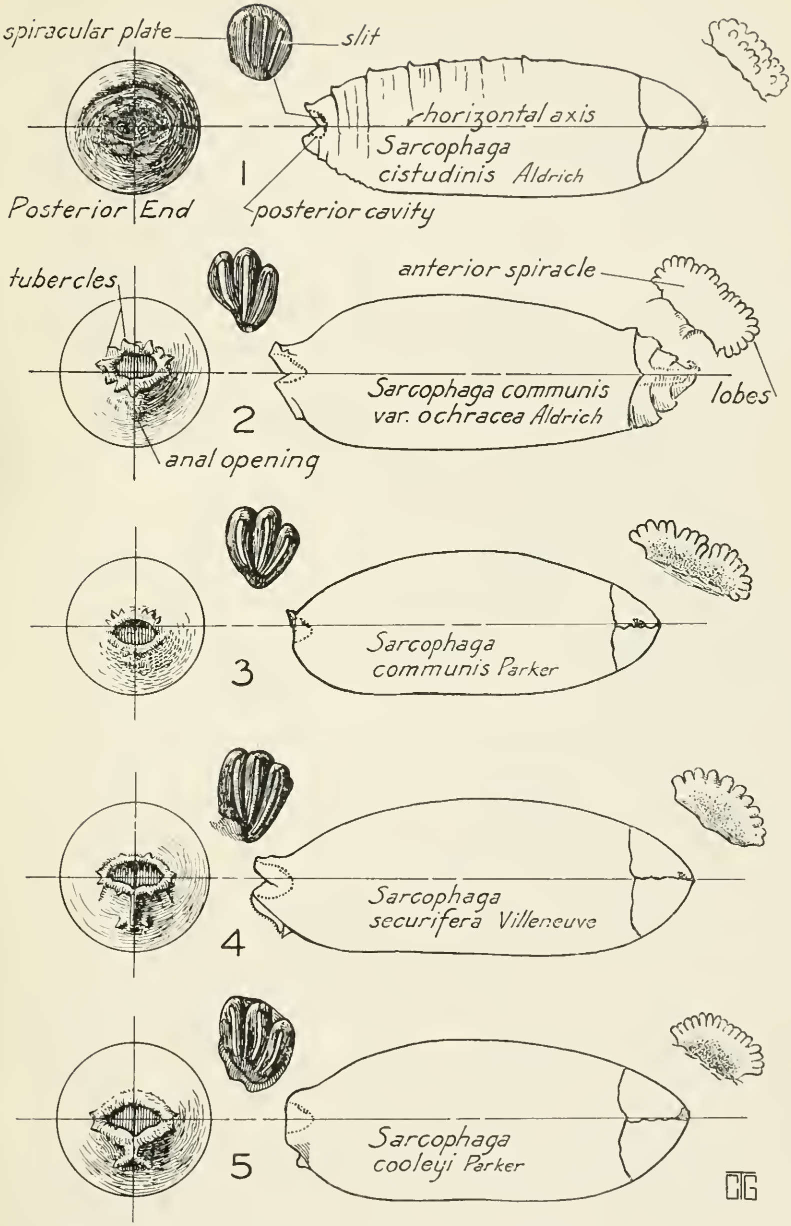

THE PUPARIA OF SARCOPHAGID FLIES

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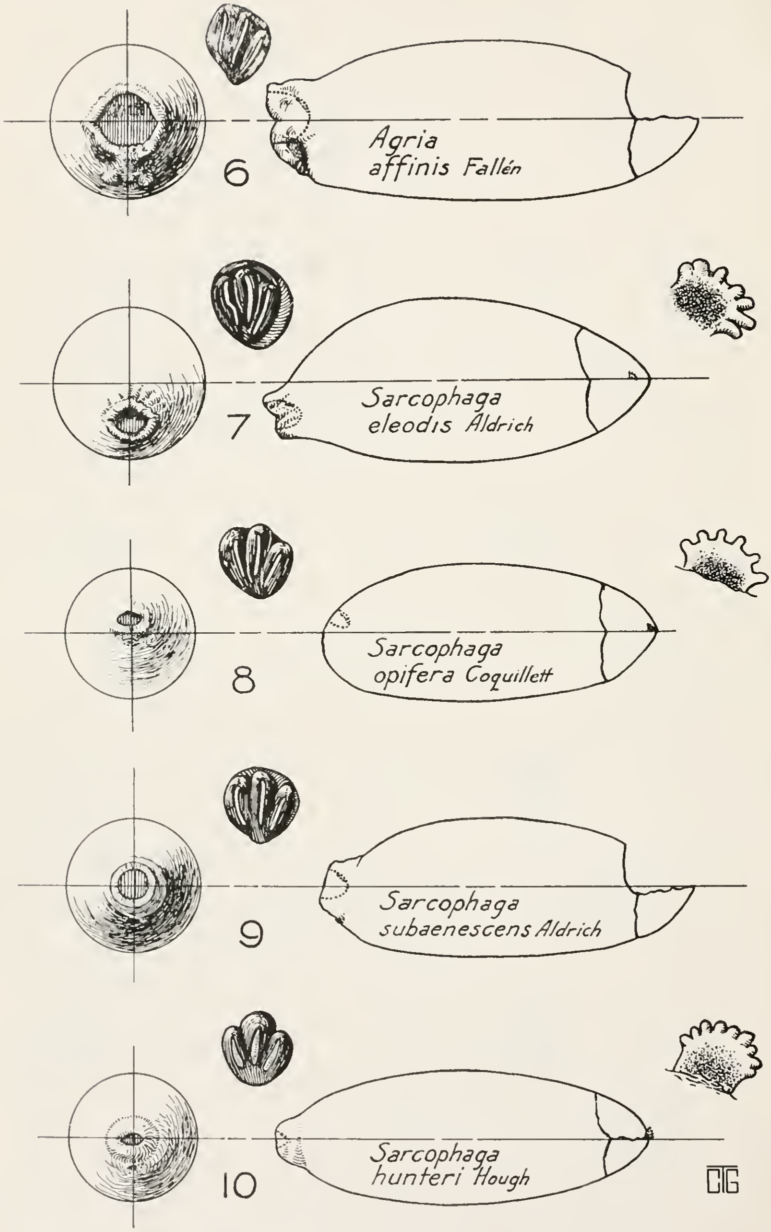

THE PUPARIA OF SARCOPHAGID FLIES

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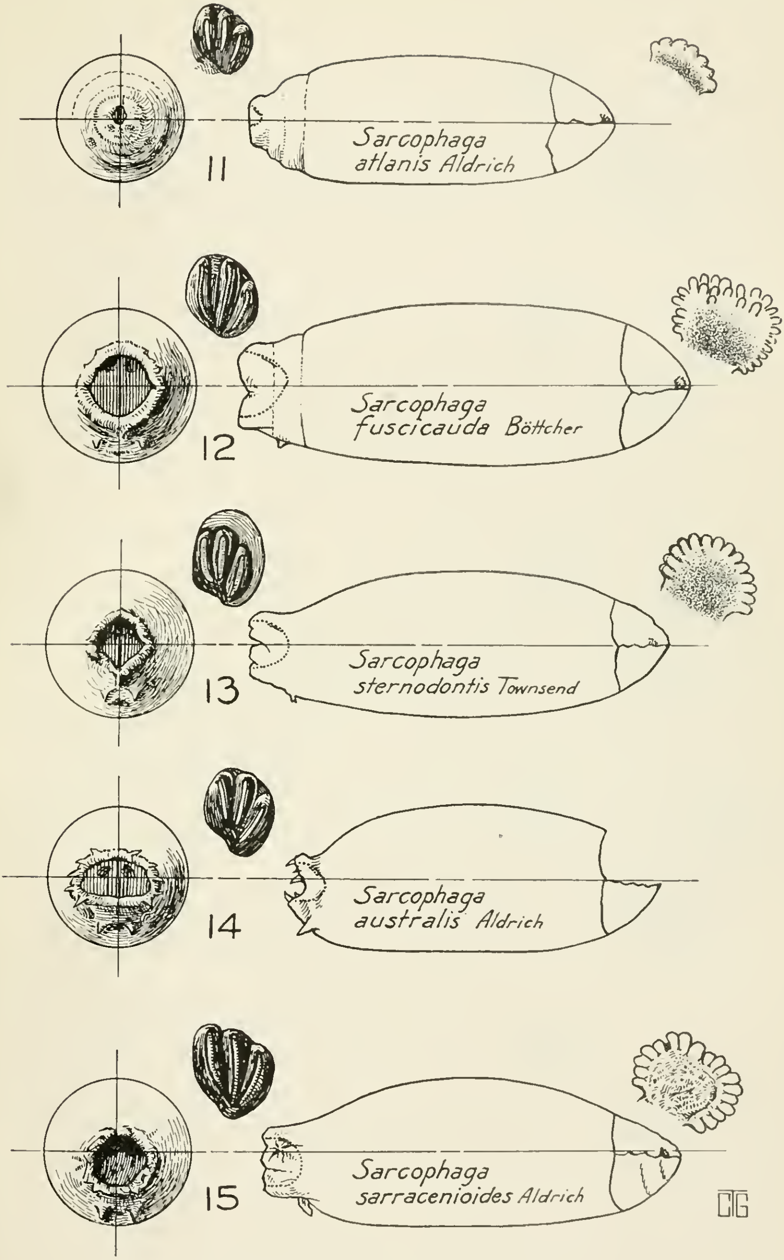

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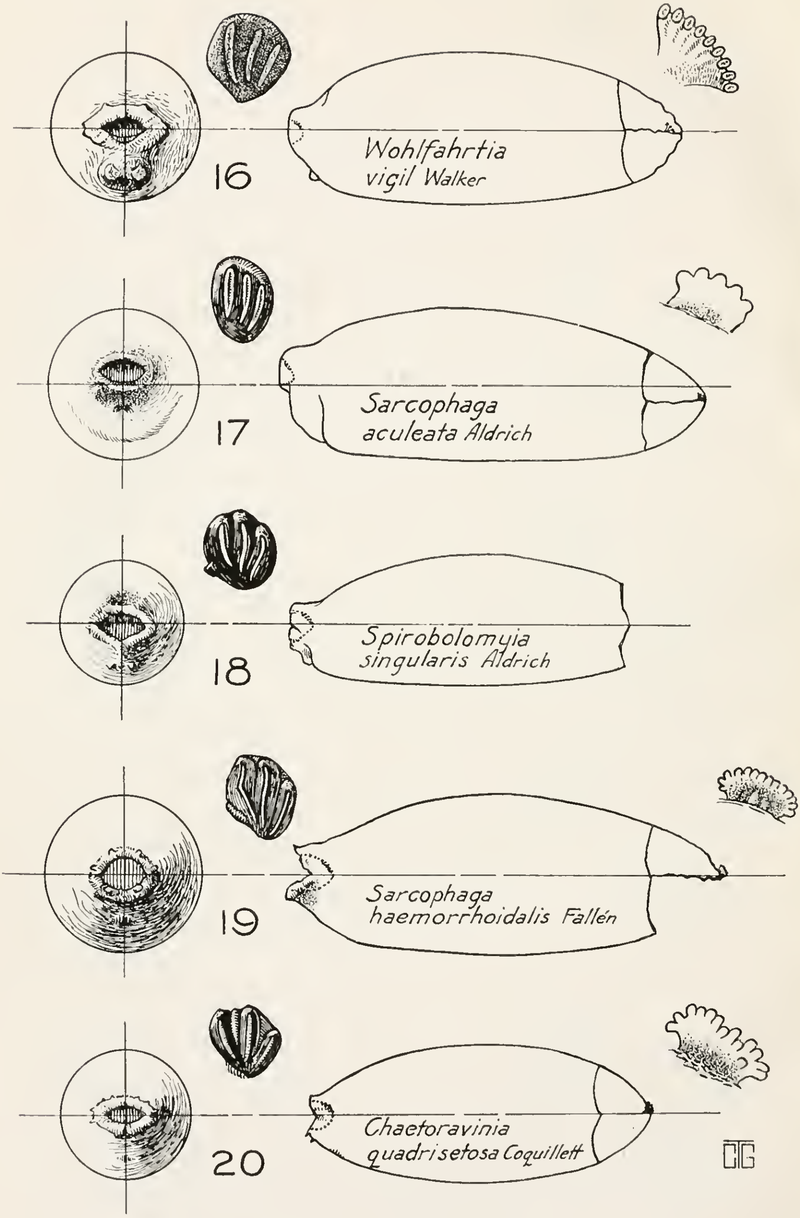

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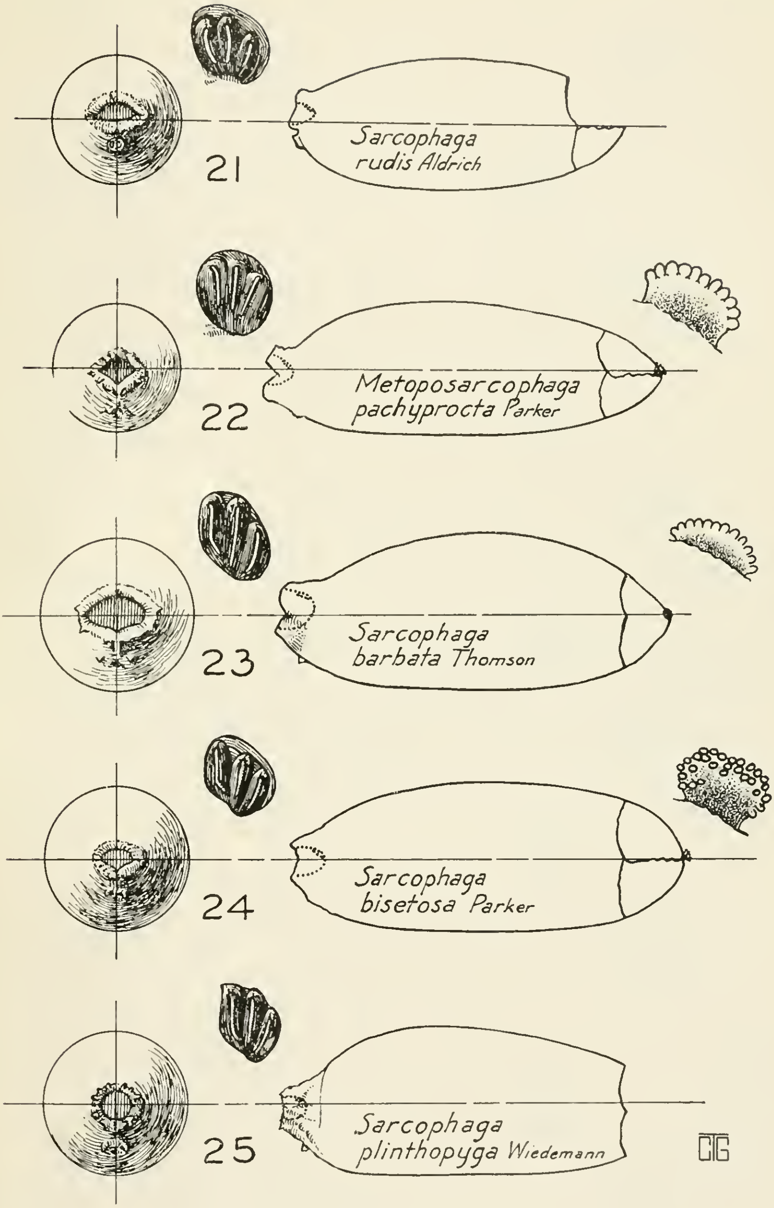

THE PUPARIA OF SARCOPHAGID FLIES

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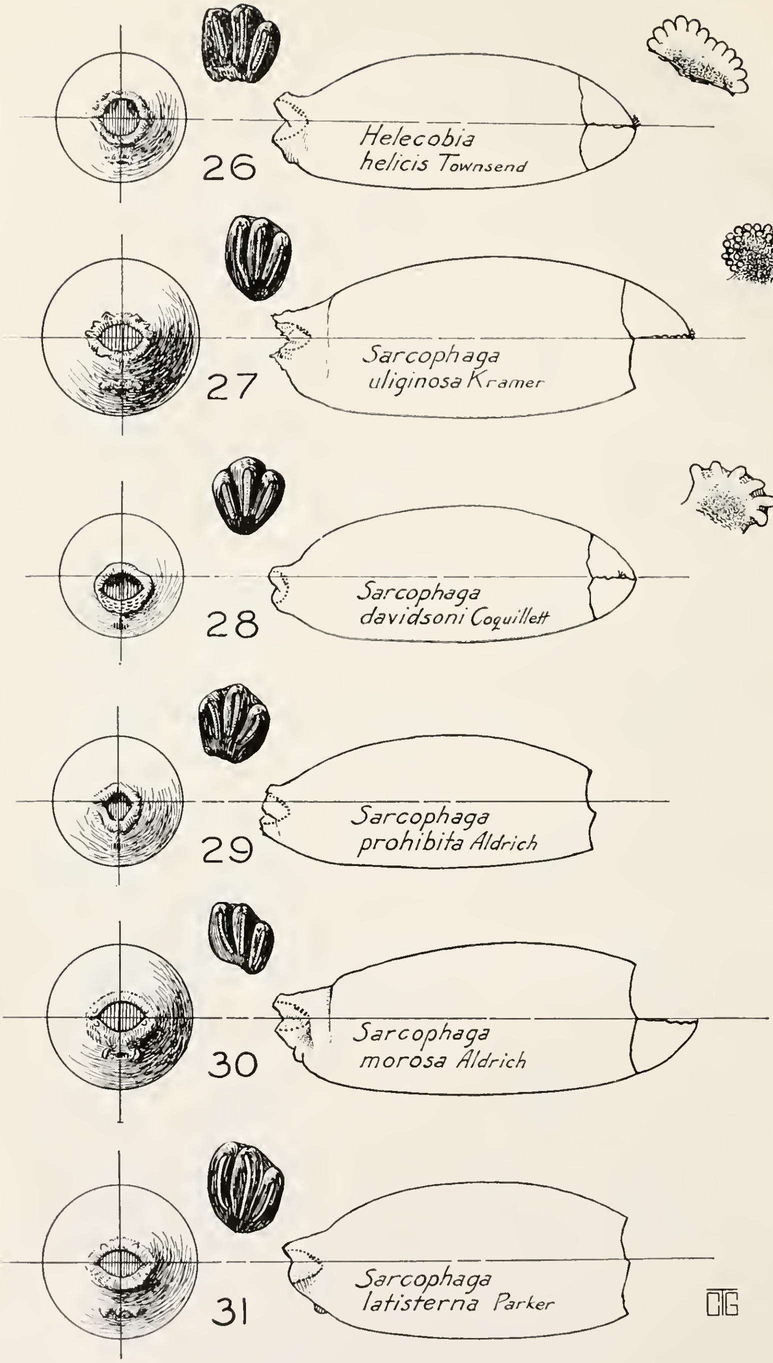

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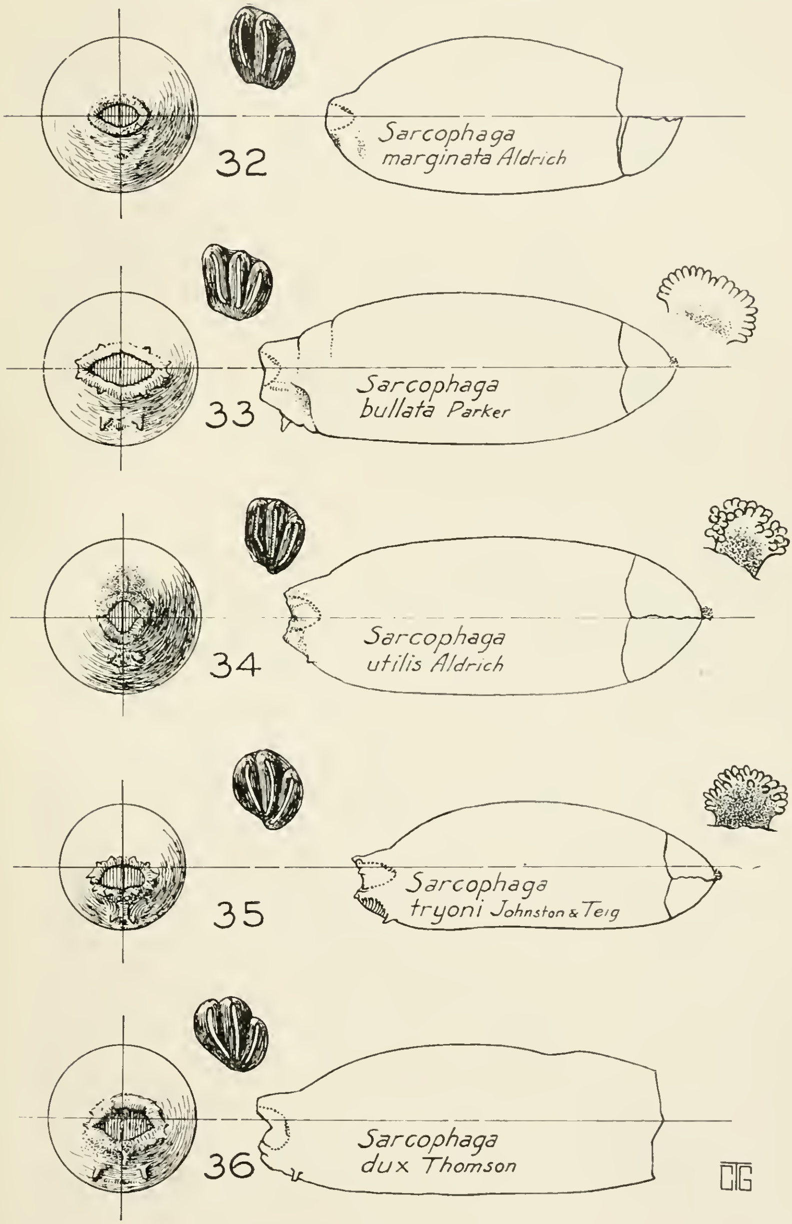

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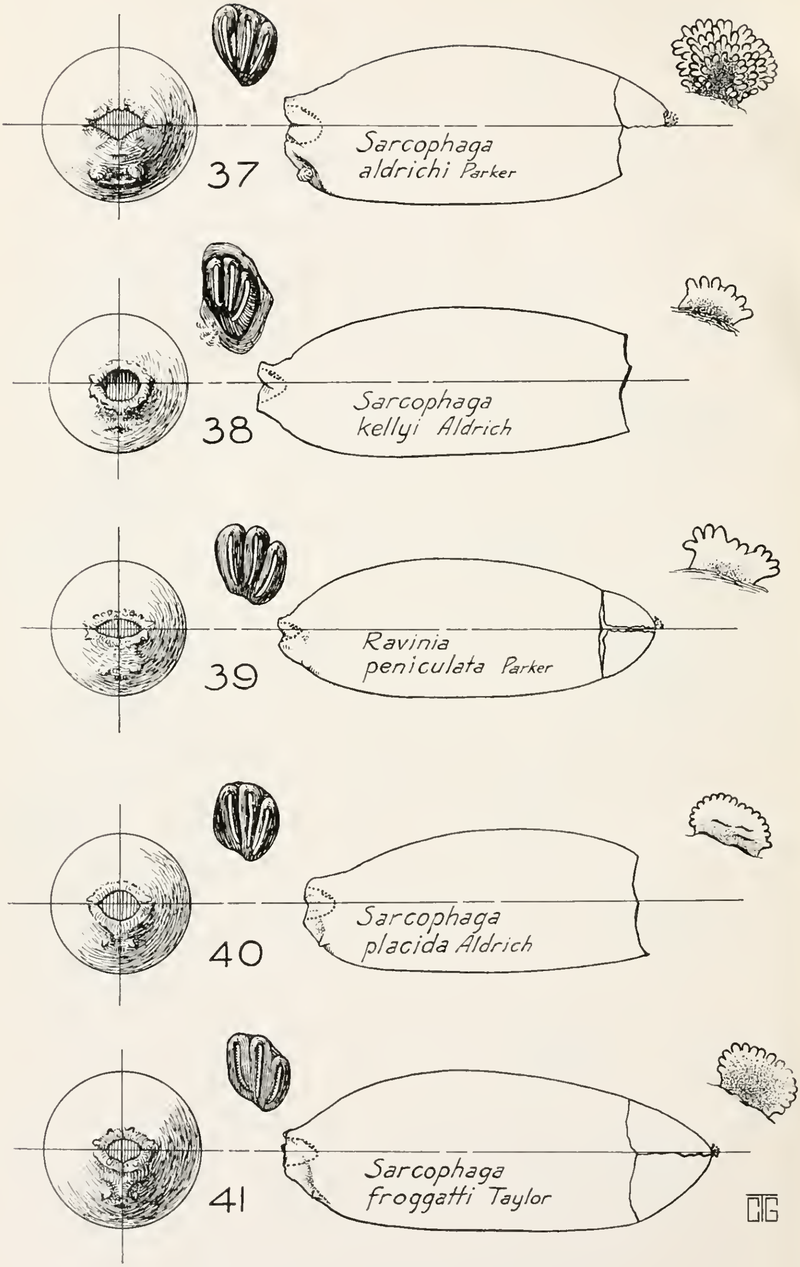

THE PUPARIA OF SARCOPHAGID FLIES

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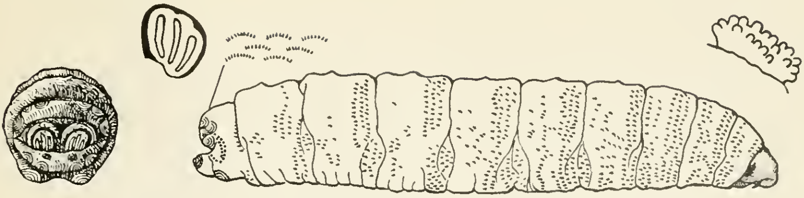
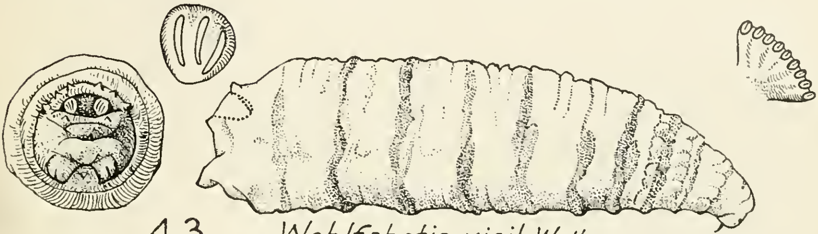
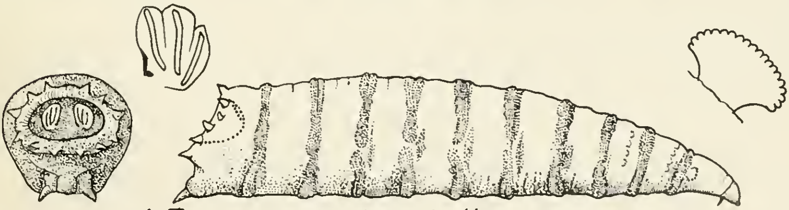


42 *Sarcophaga cistudinis* Aldrich



43 *Wohlfahrtia vigil* Walker

44 *Sarcophaga placida* Aldrich



45 *Sarcophaga bullata* Parker

46 *Sarcophaga securifera* Villineuve

THE LARVAE OF SARCOPHAGID FLIES

FOR EXPLANATION OF PLATE SEE PAGE 26

A NEW GENUS OF EOCENE FORAMINIFERA

By Joseph A. Cushman
Of Sharon, Massachusetts

In the American Tertiary there are numerous foraminifera representing several species which it is difficult to assign to any existing genus. The nearest species to these is that described by Hantken as *Siderolina kochi* Hantken.[1] A figure of this is given here. The American species are all different from this.

The genus *Siderolina* was erected by Defrance[2] and is the same as *Siderolites* Lamarck[3] the type species being *S. calcitrapoides* Lamarck. This has been at various times assigned to *Siderolina* Defrance of which it is the type and to *Calcarina* d'Orbigny. The model of d'Orbigny of *Siderolina* is of *S. laevigata* d'Orbigny and may probably be referred to *Siderolites.* That genus has the young rotaliform and later vesicular chambers cover the early chambers. These Eocene species referred to here are planospiral, consisting of but a few chambers usually each with a distinct spine and while they should probably be referred to the Rotaliidae are very different from *Siderolites* or *Calcarina.* The following genus is proposed for them:

HANTKENIA, new genus

Description.—Test free, planospiral, consisting of about three coils, chambers few, usually about five in the adult coil, laterally compressed, wall finely or coarsely perforate, sutures distinct and depressed, each chamber at least in the adult with a stout peripheral spine with a hollow center, aperture tripartite one arm running along either side of the base of the chamber, the other extending peripherally in the apertural face of the chamber.

Type species.—*Hantkenina alabamensis*, new species, from the *Zeuglodon* bed at Cocoa post office, Alabama.

[1] A magy. kir. földt. int. évkönyve, vol. 4, 1875 (1876), p. 68, pl. 16, fig. 1 and Mitth. Jahrb. ung. geol. Anstalt, vol. 4, 1875 (1881), p. 79, pl. 16, fig. 1.
[2] Dict. Sci. Nat., vol. 32, 1824, p. 180.
[3] Syst. Anim. sans Vert., 1801, p. 376.

No. 2567.—Proceedings U. S. National Museum, Vol. 66, Art. 30.
9122—24

In the Tertiary of America there are at least four species and to this genus should be referred Hantken's species. These are all described below and figures are given of all of them. They seem to mark the Uppermost Eocene in Alabama and elsewhere on our Gulf Coastal Plain and the Mexican species from the Alazan are closely related. Hantken's species is from the *Clavulina*-Szaboi beds of Hungary.

HANTKENINA KOCHI (Hantken)

Plate 2, fig. 1.

Siderolina kochi Hantken, A magy. kir. földt. int. évkönyve, vol. 4, 1875 (1876), p. 68, pl. 16, fig. 1; Mitth. Jahrg. ung. geol. Anstalt, vol. 4, 1875 (1881), p. 79, pl. 16, fig. 1.

Description.—Test planospiral, laterally compressed, adult coil composed of five chambers, wall smooth, sutures slightly depressed, distinct, each chamber in the adult with a rapidly tapering spine in the last formed chambers nearer the apertural side, hollow, aperture not shown.

Diameter 0.5 mm.

The type specimen as described from the *Clavulina*-Szaboi beds of Porna, Hungary, was a unique, no other specimens being known.

Hantken speaks of the aperture being formed by the tubelike projection, but this is evidently an error, as the hollow spines would give this appearance. The aperture may have been filled and indistinct.

HANTKENINA BREVISPINA, new species

Plate 2, fig. 3

Description.—Test somewhat compressed, planospiral, six chambers in the adult coil, periphery not lobulate, wall distinctly perforate, each chamber with a short hollow spine broad at the base, chambers of the umbilical area slightly visible.

Diameter without spines 0.45 mm., with spines 0.65 mm.

Type specimen.—Cat. No. 353079, U.S.N.M., from Mexico. Light colored clay, lower 20 feet of exposure, Rio Pantepec, 2.2 kms. S. 20° W. from Buena Vista, T. W. Vaughan, Collector.

This species has much shorter and stouter spines than the other species of the genus.

HANTKENINA LONGISPINA, new species

Plate 2, fig. 4

Description.—Test planospiral, compressed, chambers rapidly increasing in size and height as added, five or six in the adult coil, those of the early coils showing slightly at the umbilicus, each chamber with a long stout spine, often somewhat longer than the

chamber, hollow centered, wall very finely punctate, periphery somewhat lobulate.

Diameter without spines 0.5 mm., with spines nearly 1 mm.

Type specimen.—Cat. No. 353080, U.S.N.M., from Mexico. Dark gray clay, Rio Tuxpan, crossing of road from Palo Blanco to La Noria and along Rio Pantepec about 200 meters above its mouth, T. W. Vaughan, Collector.

This species has much longer spines than any of the others. This occurs with *Orthophragmina.*

HANTKENINA MEXICANA, new species

Plate 2, fig. 2

Description.—Test planospiral, umbilicate, five or six chambers in the adult coil, rapidly elongating as added and peripherally extended to the base of the very large stout hollow spine at the periphery of the chamber, wall coarsely punctate, periphery of test much lobulated.

Diameter without spines 0.5 mm., with spines 0.75 mm. or more.

Type specimen.—Cat. No. 353081, U.S.N.M., from Mexico. Yellowish brown clay, La Laja, Zardo Creek, 1 kilometer southwest of Tierra Colorado, T. W. Vaughan, Collector.

This occurs with *Orthophragmina.*

HANTKENINA ALABAMENSIS, NEW SPECIES. APERTURAL VIEW SHOWING THE MEDIAN APERTURE AND THE ALAR PROJECTIONS FROM IT TOWARD THE BASE.

HANTKENINA ALABAMENSIS, new species

Plate 1, figs. 1–6; plate 2, fig. 5

Description.—Test planospiral, compressed, adult coil with five or six chambers, periphery very slightly if at all lobulated, wall very finely punctate, smooth, granular near the aperture, each chamber with a hollow, slender, acicular spine at the periphery, pointing somewhat anteriorly; aperture tripartite, with an elongate projection along each side at the base of the apertural face, and the third, median, extending peripherally from the base of the apertural face.

Diameter without spines 0.45 mm., with spines 0.75 mm.

Type specimen.—Cat. No. 353082, U.S.N.M., from the Eocene of the *Zeuglodon* bed at Cocoa post office, Alabama, where it is very abundant. It occurs in other parts of the Coastal Plain in the Upper Eocene.

There are specimens from Mexico in the United States National Museum collections which seem identical with this species. They are

from fine sandy clay, Rio Buena Vista, just south of crossing of Alazan to Moyutla road, Vera Cruz; fossil horizons 3 and 4; light gray sandy clay, Rio Tuxpan, south side just above Agua Nacida, Vera Cruz, all three lots collected by T. W. Vaughan.

This is the most delicate of the various species.

EXPLANATION OF PLATES

Plate 1

Hantkenina alabamensis, new species

Figs. 1–6. Side views of six specimens from Cocoa post office, Alabama. × 60

Plate 2

Fig. 1. *Hantkenina kochi* Hantken. Side views and apertural view. (After Hantken.)
2. *Hantkenina mexicana*, new species. Side view. × 75.
3. *Hantkenina brevispina*, new species. Side view. × 75.
4. *Hantkenina longispina*, new species. Side view. × 75.
5. *Hantkenina alabamensis*, new species. Side view of Mexican specimen. × 75.

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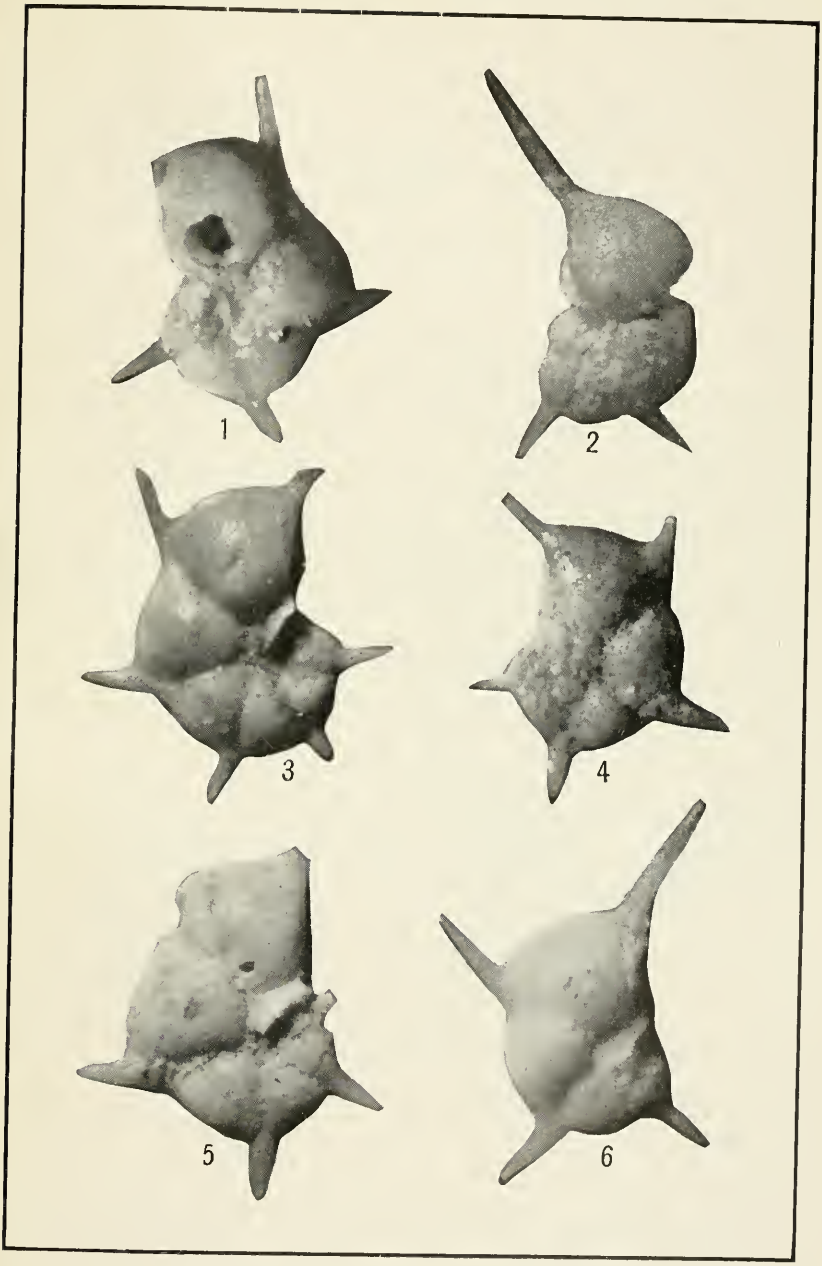
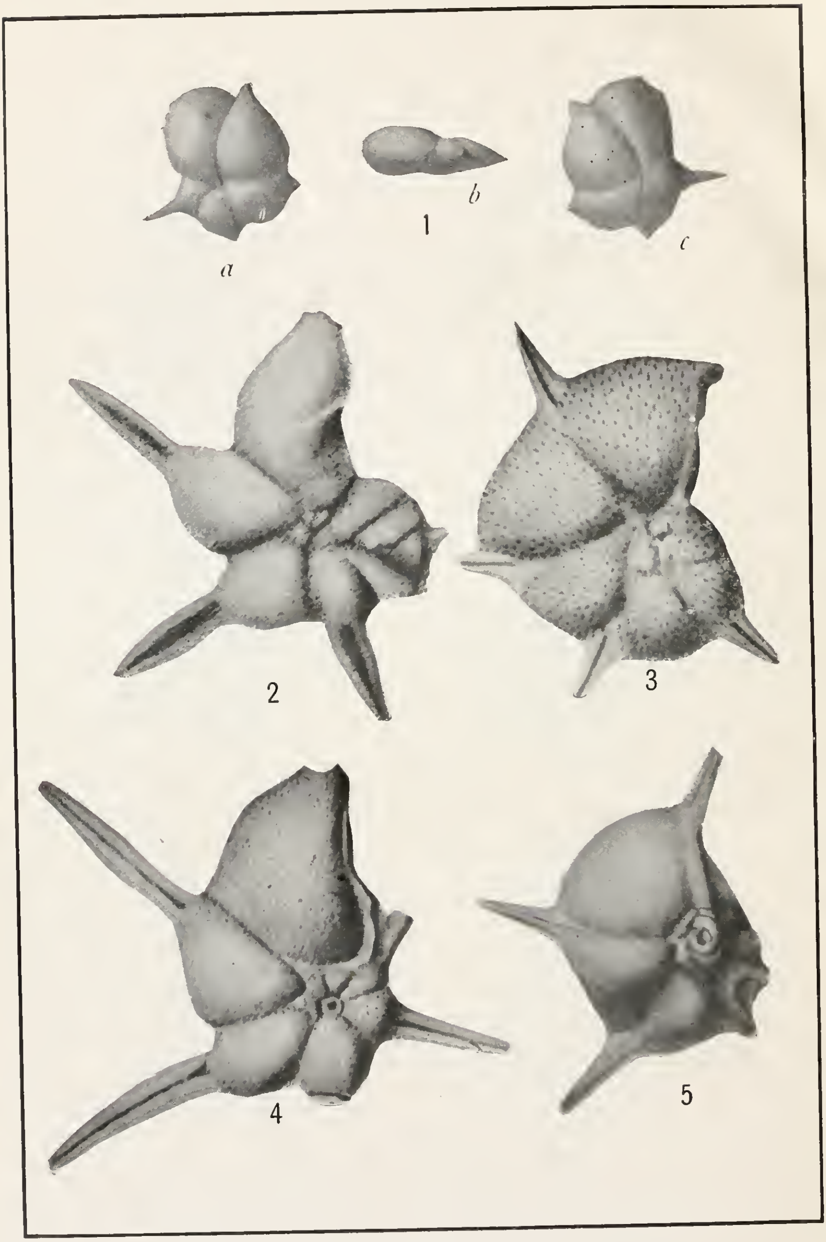


HANTKENINA ALABAMENSIS, NEW SPECIES

FOR EXPLANATION OF PLATE SEE PAGE 4



Side Views of Various Species of Hantkenina

For explanation of plate see page 4

BUPRESTID BEETLES COLLECTED BY THE MULFORD BIOLOGICAL EXPLORATION IN BOLIVIA

By Warren S. Fisher,
Of the Bureau of Entomology, United States Department of Agriculture

The present paper is the results of a study of the material of the family Buprestidae collected by the Mulford Biological Exploration during 1921–1922. This material was all collected in Bolivia, and so far as I know, no species of this family have been previously recorded from the region covered by this expedition, hence, as might be expected, a large portion of the material proved to be of species new to science, this being especially true of the smaller forms. All of the specimens, except where noted, were collected by William M. Mann.

All of this material, including the types, has been deposited in the United States National Museum, and consists of 45 species, 29 of which are described as new.

PELECOPSELAPHUS ELONGATUS Thomson

Pelecopselaphus elongatus Thomson, Typ. Bupr., 1878, pp. 24–25.

This species is represented by a single specimen collected at Tumupasa, Bolivia, during December, 1921.

CHRYSESTHES TRIPUNCTATA (Fabricius)

Buprestis tripunctata Fabricius, Mant. Ins., vol. 1, 1787, p. 179.

One specimen collected at Rurrenabaque (Beni River), during December, 1921.

EUCHROMA GIGANTEA, var. GIGANTEA (Linnaeus)

Buprestis gigantea Linnaeus, Syst. Nat., 10 ed., 1758, p. 408.

This species is represented by nine specimens collected at Rurrenabaque (Beni River), Rosario (Lake Rogagua) during November, and at Isiamas during December, 1921.

No. 2568.—Proceedings U. S. National Museum, Vol. 66, Art. 31
12050—25——1

CHRYSOBOTHRIS ROGAGUAENSIS, new species

Male.—Form rather broadly oblong and feebly convex, with the surface subopaque; color aeneo-brunneus, with a feeble cupreous or purplish tinge, the head more or less ornated with bright green, which is more distinct on the epistoma, along the lateral margins and antennal cavities, and sometimes with two small round spots on the front; antennae green at base, becoming reddish-cupreous toward the apex; each elytron with three irregular foveae, a rather deep one at basal lobe, an obsolete irregular one at middle divided by the second costa, and a more distinct zigzag one near apical third, extending between the second and fourth costae, the foveae are nearly concolorous, but in some specimens they are more distinctly aeneous or cupreous; beneath aeneo-brunneus, with a strong cupreous tinge at the sides, becoming golden-green, with a strong cyaneous reflection on the median parts and tibiae, the tarsi cyaneous.

Head feebly convex, with the front triangular, the sides strongly obliquely narrowed toward the top, and with three irregular transverse carinae which do not extend to the lateral margins, and arranged as follows: a very narrow sinuate one, broadly interrupted at middle, and situated behind the antennal cavities, a broader, feebly arcuate one on the front, and a narrow one on the vertex; surface coarsely and irregularly punctate, the punctures more shallow and widely separated on the front, becoming deeper and confluent on vertex and along the eyes, sparsely clothed with fine long recumbent cinereous hairs; intervals finely and densely granulose; eyes large, moderately convex, top and bottom about equally rounded, and separated from each other on the occiput by about the same distance as between the antennal cavities; epistoma feebly and broadly arcuately emarginate in front, the lobes on each side very broadly rounded; antennae rather short, the third joint about as long as the following two joints united. Pronotum strongly transverse, nearly two times as wide as long, widest along middle, apex and base about equal in width; sides strongly obliquely expanded from anterior margin to apical fourth, then parallel to basal third, except for a regular arcuate emargination, and finally obliquely narrowed to the posterior angles, which are obtusely angulated; anterior margin broadly arcuately emarginate, with only an obsolete median lobe; base strongly arcuately emarginate on each side at the elytral lobes, the median lobe broadly rounded and narrowly truncate in front of the scutellum; surface feebly convex, with an obsolete longitudinal median sulcus, and with two more or less distinct round depressions on each side of the middle, the posterior pair broader and more widely separated than the anterior pair, there is also an irregular flattened depression on each side along the lateral margin, finely and irregularly punctate, the punctures widely separated on the disk, but becoming more confluent

toward the sides, the intervals smooth, transversely rugose toward the sides, where the depressions are finely and densely granulose. Scutellum triangular, longer than wide, strongly acuminate at apex, with the surface smooth. Elytra distinctly wider than pronotum at base, sides broadly rounded at humeral angles, parallel to apical third (feebly concave at basal third), then arcuately attenuate to the tips, which are conjointly rather acutely rounded, lateral margins coarsely serrate to the middle, the teeth large and rather evenly spaced; humeri not prominent; base strongly angularly lobed; surface finely and irregularly punctate, the punctures shallow and more widely separated on the disk, becoming deeper and more confluent in the depressions and at the sides, and each puncture with a minute pit-like depression at the middle, the intervals smooth; each elytron with the sutural margin strongly elevated posteriorly, and with four more or less distinct longitudinal costae, the first parallel to the sutural margin, strongly elevated posteriorly, abruptly expanded at basal third and extending to the basal depression, the second more feebly elevated and extending from base to the apical depression, the third very arcuate, extending around the external margin of humerus to near the apex, and broadly interrupted by the apical depression, and the fourth parallel with the lateral margin, extending from behind the humerus to the apex and nearly connected to the first costa. Abdomen beneath sparsely, coarsely and irregularly punctate, the punctures open posteriorly, and larger and somewhat confluent toward the sides, where the surface is also sparsely clothed with long recumbent cinereous hairs; intervals smooth; first segment broadly, longitudinally concave at middle; last segment broadly longitudinally concave at middle, with the lateral margins entire, the submarginal ridge only prominent on each side of the apical emargination, and the apex deeply, broadly, arcuately emarginate. Prosternum transversely truncate in front; surface transversely narrowly concave behind the anterior margin, rather coarsely, sparsely and irregularly punctate, becoming transversely rugose toward the sides, and sparsely clothed with long cinereous hairs; prosternal process flat, strongly expanded behind the coxal cavities, with a very large triangular tooth at apex. Femora robust; anterior pair with a large obtuse tooth on the outer edge, closer to the apex than base, and coarsely and irregularly serrate on the exterior margin. Anterior and middle tibiae strongly arcuate, subcylindrical and without any dilatation, the posterior pair straight and subcylindrical.

Female.—Differs from the male in having the head more cupreous, last abdominal segment not concave at middle, but with two large depressions on each side along base, the submarginal ridge more prominent, strongly serrate, broadly rounded at apex and not in-

terrupted at the middle, the apex not as deeply emarginate, and with an obsolete tooth at the middle of the emargination.

Length, 11.5–14 mm.; width, 4.75–5.5 mm.

Type locality.—Rurrenabaque (Beni River), Bolivia.

Other localities.—Rosario (Lake Rogagua), Bolivia.

Type, allotype and paratypes.—Cat. No. 26964, U.S.N.M.

Described from six specimens, four males and two females. The type and allotype collected at the type locality during November, 1921; and four paratypes, 3 males and one female, collected at Rosario, during the same month.

CHRYSOBOTHRIS FRONTALIS (Olivier)

Buprestis frontalis Olivier, Entom., vol. 2, 1790, gen. 32, pp. 45–46, pl. 5, fig. 44.

One specimen collected at Cavinas (Beni River), during February, 1922.

CHRYSOBOTHRIS RUBIMACULATA (Castelnau and Gory)

Colobogaster rubimaculata Castelnau and Gory, Mon. Bupr., vol. 2, 1836, pp. 10–11, pl. 2, fig. 9.

Represented by five specimens collected at Rosario (Lake Rogagua), during November, 1921.

CHRYSOBOTHRIS BENIENSIS, new species

Female.—Form rather broadly oblong and feebly convex, and with the surface moderately shining; above piceous, with a strong bluish, greenish, or purplish tinge, the head with the lateral margins, front of epistoma, and antennal cavities narrowly margined with a bright green or cupreous color; antennae bright green on basal joints, becoming more aeneous toward the apex; each elytron with three round deeply depressed foveae, which are golden-green margined with cupreous, one in the basal depression, one on the disk at middle, and the other at the apical third and situated closer to the lateral margin than the suture; color beneath similar to above, except on the median parts, where it is bright green or cupreous; tarsi cyaneous.

Head moderately convex, with the front triangular, the sides strongly obliquely narrowed toward the top, with an obsolete arcuate carina between the vertex and occiput, a broad obsolete depression on the front, and a distinct narrow longitudinal carina on the occiput; surface coarsely and densely punctate, the punctures becoming transversely rugose on the front, and sparsely clothed with long semi-erect cinereous hairs; intervals smooth; eyes large, feebly convex, more acutely rounded at bottom than on top, and separated from each other on the occiput by four-fifths of the distance between the antennal cavities; epistoma broadly, angularly, and rather deeply emarginate in front, the lobes on each side broadly rounded; antennae

short and robust, the third joint about as long as the following four joints united. Pronotum strongly transverse, two times as wide as long, base and apex about equal in width, widest at apical fourth; sides strongly obliquely expanded to apical fourth, where they are obtusely angulated, then obliquely attenuate to the posterior angles, which are obtuse (in some specimens the sides are feebly sinuate behind the apical fourth); anterior margin broadly arcuately emarginate, with an obsolete broadly rounded median lobe; base strongly arcuately emarginate on each side at the elytral lobe, the median lobe broadly rounded and narrowly truncate in front of the scutellum; surface feebly convex and obsoletely uneven, with a more distinct broad depression along lateral margin at apical third, and a similar one in front of elytral lobe, finely, rather densely and regularly punctate, sometimes becoming obsoletely transversely rugose toward the sides, the intervals smooth. Scutellum triangular, the three sides about equal in length, with the surface finely, densely granulose. Elytra distinctly wider than pronotum at base; sides broadly rounded at humeral angles, parallel to just behind the middle (feebly concave at basal third), then arcuately attenuate to the tips, which are rather acutely rounded, lateral margins finely serrate to basal third; humeri feebly developed; base strongly angularly lobed; surface densely, finely, and regularly punctate, and the intervals smooth; each elytron with two more or less distinct longitudinal costae, one parallel to the sutural margin, and extending from the apex to middle, the other along the lateral margin, extending from behind the humerus to the apex, where it is connected to the other costa. Abdomen beneath coarsely and irregularly punctate, the punctures widely separated on the median parts, but becoming denser and finely rugose on the antero-lateral areas of the segments, where the surface is also rather densely clothed with long recumbent cinereous hairs; intervals smooth; first segment not distinctly concave at middle; last segment convex, or with an obsolete broadly rounded carina at middle, the lateral margins variable, entire or with a more or less abrupt emargination on each side near the apex, and without a submarginal ridge; the apex with two deep semi-circular emarginations. Prosternum truncate in front, with the anterior margin strongly elevated; surface narrowly, transversely depressed behind the anterior margin, coarsely, very densely punctate, and sparsely clothed with long recumbent cinereous hairs toward the sides; prosternal process flat, strongly expanded behind the coxal cavities, and with a very large triangular tooth at apex. Femora robust; anterior pair strongly swollen at middle, with a large obtuse triangular tooth on the outer margin, closer to the apex than base, and feebly serrate on the exterior margin; middle pair slightly swollen at middle; the posterior pair subcylindrical, and feebly flattened. Anterior tibiae feebly

arcuate, strongly expanded and flattened toward apex, and without any dilatation on the inner margin; middle and posterior pairs subcylindrical, the middle pair feebly arcuate, and the posterior pair straight.

Male.—Unknown.

Length, 9–14 mm.; width, 4–6 mm.

Type locality.—Cavinas (Beni River), Bolivia.

Type and paratypes.—Cat. No. 26965, U.S.N.M.

Described from nine specimens, probably all females, collected at the type locality during January and February, 1922.

CHRYSOBOTHRIS SEXPUNCTATA (Fabricius)

Buprestis sexpunctata FABRICIUS, Syst. Eleuth., vol. 2, 1801, p. 206.

Eighteen specimens collected at Cavinas (Beni River) during January and February, 1922.

CHRYSOBOTHRIS DECOLORATA (Castelnau and Gory)

Colobogaster decolorata CASTELNAU and GORY, Mon. Bupr., vol. 2, 1836, p. 11, pl. 2, fig. 10.

A single example collected at Cavinas (Beni River) during January, 1922.

CHRYSOBOTHRIS CUPRIFRONS, new species

Female.—Form narrowly oblong and feebly convex, and with the surface shining; head reddish-cupreous, with the lateral margins, anterior margin of epistoma and margins around antennal cavities bright green; antennae bright green on basal joints, becoming darker green toward the apex; pronotum olive-green, becoming rubinous along the anterior margin; elytra blackish-green, with a strong purplish or reddish-cupreous reflection when viewed in different lights, and each elytron ornated with three bright green spots, a narrow oblong one at basal depression, a very narrow oblique one behind humerus, extending forward along the lateral margin, and becoming more or less obsolete around the humeral angle, and a rounded one (emarginated anteriorly and posteriorly) on disk just in front of the middle; beneath olive-green, with strong purplish tinge at the sides, the median parts of a brighter green, with a strong bluish or purplish tinge; tarsi cyaneous.

Head broadly depressed on the front, which is triangular, the sides strongly obliquely narrowed toward the top, and with two broadly arcuate transverse carinae on the vertex, the anterior one broad and strongly elevated, the posterior one nearly obsolete; occiput with an obsolete longitudinal carina; surface coarsely and densely punctate, the punctures round, fine, and distinctly separated on the occiput,

becoming much coarser, very irregular in shape, and confluent in the frontal depressed area, bottom of the punctures finely, densely granulose, and sparsely clothed with long semierect cinereous hairs; eyes large, strongly convex, more broadly rounded at bottom than on top, and separated from each other on the occiput by about one-half of the distance between the antennal cavities; epistoma feebly and broadly arcuately emarginate in front, the lobes on each side only feebly rounded; antennae very short, the third joint about as long as the following four joints united. Pronotum strongly transverse, two times as wide as long, slightly narrower in front than behind; sides strongly obliquely expanded to apical fifth, then parallel, or at most, only obsoletely arcuate to the posterior angles, which are acute; anterior margin nearly truncate; base deeply arcuately emarginate on each side at elytral lobe, and with a large broadly rounded median lobe; surface feebly, regularly convex, with a broad obsolete depression in front of scutellum, feebly transversely rugose, with a few very fine, irregularly placed punctures between the rugae on disk, the punctures becoming denser and coarser on the antero-lateral region, the bottom of the punctures obsoletely granulose and with a pitlike depression at the center, the intervals obsoletely granulose. Scutellum very small, triangular; surface finely granulose, with a deep fovea at the middle. Elytra distinctly wider than pronotum at base; sides obtusely rounded at the humeral angles, parallel to just behind the middle (feebly concave at basal third), then obliquely attenuate to the tips, which are acutely rounded, lateral margins coarsely serrate to near the middle, the teeth large and rather evenly spaced except at apex; humeri not prominent; base strongly angularly lobed; surface sparsely and finely punctate, the punctures very fine and widely separated on the disk, becoming coarser, more confluent and somewhat transversely rugose toward the lateral margins and in the depressed green areas, and without longitudinal costae, intervals smooth; each elytron with a deep basal depression, a more shallow one at humerus, and with the green spot on disk broadly but feebly depressed. Abdomen beneath sparsely, coarsely and regularly punctate on the median parts, becoming very finely and densely punctate on the antero-lateral areas of the segments, where the surface is also densely clothed with long recumbent cinerous hairs; intervals smooth; first segment obsoletely concave at the middle; last segment with a broadly rounded obsolete median carina, the lateral margins entire, and without a submarginal ridge; apex broadly rectangularly emarginate, the emargination deep, feebly sinuate at middle, the sides rounded at bottom and produced into a long sharp tooth at apical angles. Prosternum with a narrow, broadly rounded median lobe in front, and the anterior margin elevated; surface feebly transversely

concave behind the anterior margin, coarsely, densely punctate, and sparsely clothed with moderately long recumbent cinereous hairs toward the sides; prosternal process flat, strongly expanded behind the coxal cavities, and with a very large, acutely triangular tooth at apex. Femora robust; anterior pair short, strongly swollen, the outer margin flattened, arcuately expanded, but not forming a distinct tooth; the middle and posterior pairs subcylindrical, feebly flattened, and the middle pair slightly more swollen at middle. Anterior and middle tibiae strongly arcuate, subcylindrical, and without any dilatations; the posterior pair straight and subcylindrical.

Male.—Unknown.

Length, 12.5 mm.; width, 5 mm.

Type locality.—San Antonio, Bolivia.

Type.—Cat. No. 26966, U.S.N.M.

Described from a unique female collected during November, 1921.

ACTENODES FULMINATA (Schönherr)

Buprestis fulminata Schönherr, Syn. Ins., vol. 1, pt. 3, App., 1817, p. 121.

A single example of this species collected at Tumupasa, Bolivia, during December, 1921.

ACTENODES MANNI, new species

Form narrowly elongate, feebly convex, attenuate in front, and more acuminate posteriorly, glabrous and rather shining; head and pronotum olive green, with a strong purplish reflection; elytra nigro-purpureous, with a distinct olive green tinge, and each elytron ornated with three green spots, a broad transverse one at base, extending narrowly along margin to behind the humerus, an elongate oblique one along lateral margin at apical third, and a rather large irregular one on disk in front of middle and situated obliquely behind the marginal spot, the spots not depressed except the basal one; beneath aeneo-cupreous, with a feeble purplish tinge; tarsi cyaneous.

Head feebly convex, with the front strongly triangular, and the sides strongly obliquely narrowed toward the top, with a broad, moderately deep concave depression on the vertex, which is longitudinally, narrowly and obsoletely impressed to the epistoma; occiput with a narrow longitudinal carina; surface coarsely and densely punctate, the punctures separated on the vertex and occiput, but becoming confluent and transversely rugose toward the epistoma, and each puncture with a small pitlike depression at the center, the intervals smooth and shining; eyes large, moderately convex, nearly contiguous on the occiput, where they are separated from each other by about one-sixth the distance between the an-

tenal cavities; epistoma broadly arcuately emarginate in front, with a small obtuse median tooth, and the lobes on each side broadly rounded. Pronotum strongly transverse and feebly convex, two times as wide as long, apex and base about equal in width, widest at about apical third; sides broadly rounded at apical third, then arcuately attenuate to the posterior angles, which are nearly rectangular; anterior margin deeply arcuately emarginate, without a median lobe; base nearly truncate, with an obsolete broadly rounded lobe at middle; surface with two broad transverse depressions, one along the anterior margin, the other along the base, the latter being more deeply depressed and extending to near the lateral margins, finely, sparsely punctate, and the entire surface rather densely covered with coarse rugae, which are very irregular in shape, and becoming more or less transverse on the disk, the intervals finely and densely granulose. Scutellum small, triangular, the sides about equal in length, and the surface obsoletely granulose. Elytra distinctly wider than pronotum at base; sides broadly rounded at humeral angles, nearly parallel to behind the middle (strongly concave at basal third), where they are broadly rounded, then strongly obliquely attenuate to the tips, which are very acute and terminating in a short, acute tooth, lateral margins entire, or at most only obsoletely serrate; each elytron strongly lobed at base, with a broad, deep basal depression, but without longitudinal costae; surface finely, densely and rather regularly punctate, the punctures coarser and strongly rugose in the green colored areas, the intervals obsoletely rugose at base, becoming smooth and shining toward apex. Abdomen beneath feebly convex, finely, very sparsely and scabrously punctate, becoming more or less rugose at the sides; intervals smooth at middle, and densely granulose toward the sides; last segment armed on each side with an obtuse tooth, and broadly truncate at apex. Prosternum feebly convex; anterior margin truncate, with an obsolete lobe on each side, the margin, as well as those around coxal cavities strongly elevated; surface strongly depressed behind the anterior margin and in front of coxal cavities, causing the surface to be abruptly elevated on each side in front, coarsely and sparsely punctate, and finely rugose at sides; prosternal process feebly convex, strongly expanded behind coxal cavities, and with a large acute triangular tooth at middle of apex. Posterior tibiae without a row of long hairs on the inner margin.

Length, 11.5 mm.; width, 5 mm.

Type locality.—Rurrenabaque (Beni River), Bolivia.

Type.—Cat. No. 26967, U.S.N.M.

Described from a single specimen collected during October, 1921.

The species is closely allied to *buqueti*, described from Colombia by Gory, but can be separated from that species by the pronotum not narrower in front than behind, and the lateral margins of the elytra entire posteriorly, and not serrate.

CONOGNATHA AMOENA Kirby

Conognatha amoena Kirby, Trans. Linn. Soc., London, vol. 12, 1818, p. 381.

A single example of this beautiful species was collected at Rurrenabaque (Beni River), during December, 1921.

AUTARCHONTES LOPEZI, new species

Form large, robust, and strongly shining; head cupreous, more or less aureus on the front, and becoming purplish-red, with feeble greenish reflection on the occiput; pronotum blackish-green, with a distinct purpureous or violaceous tinge, especially toward the sides; scutellum and elytra blackish-green, the latter with the apex cyaneous, the sides feebly purplish, and each elytron ornated with three small cinerous spots arranged in a straight line in the concavity near suture, and located as follows: one just in front of middle, one at apical third, and the other near apex; beneath bluish or greenish-black, with a strong purplish tinge, and the legs violaceous; tarsi and antennae piceous, with a feeble aeneous tinge.

Head with the front rather wide, feebly convex, sides feebly arcuately expanded near vertex, broadly and deeply depressed from occiput to epistoma, the depression becoming broader and more flattened behind the epistoma; surface coarsely and rather densely punctate on the front, (except behind the epistoma where it is finely, densely punctate, and sparsely clothed with fine cinereous hairs), becoming coarsely and more or less concentrically rugous on the occiput; epistoma broadly and deeply arcuately emarginate in front, with a large obtuse tooth on each side of the emargination; antennae scarcely reaching to middle of pronotum, and serrate from the fourth joint. Pronotum one and one-third times as wide as long, base and apex about equal in width, and widest at apical fourth; sides feebly arcuately expanded from apical angles to middle, then obsoletely narrowed to near the posterior angles, where they are feebly expanded, with the angles nearly rectangular; lateral margin when viewed from the side strongly sinuate and the two margins separated; anterior margin feebly arcuately emarginate, with a broadly rounded median lobe; base feebly emarginate at middle of each elytron with a broadly rounded median lobe, which is truncate in front of scutellum; disk moderately convex, with two rather deep depressions at the middle, the posterior one being broader and deeper, and on each side with a deep elongate depression on the inner side of the lateral carina, the carina distinct, and extending from

the posterior angles arcuately forward to the middle, where it is joined to the lateral margin; surface coarsely and densely rugous, the rugae more or less transverse on the disk, but becoming more irregular toward the sides, sparsely, finely punctate, and sparsely clothed with cinereous hairs in the depressed areas. Scutellum strongly, transversely carinate, and strongly acuminate at apex; surface finely and obsoletely reticulate. Elytra slightly wider than pronotum at base, feebly expanded behind the humeral angles, broadly constricted at middle, feebly arcuately expanded behind middle, then obliquely attenuate to near the tips, which are feebly expanded, subtruncate, coarsely serrate, and with a long, acute spine at the middle of each elytron; sides of abdomen broadly exposed above; disk feebly convex, and each elytron with an obsolete costa at middle, causing a rather deep concave depression along the suture, which is feebly elevated posteriorly; basal depressions broad and deep; surface shining, rather coarsely and obsoletely imbricate-punctate, and sparsely clothed with very short, inconspicuous hairs. Abdomen beneath finely and rather densely punctate, becoming irregularly striolate toward the sides, sparsely clothed with very short cinereous hairs, and with a large densely pubescent triangular spot on each side of the third segment; intervals densely and finely granulose; first segment with a small round depression at middle; last segment broadly rounded at apex; vertical portion of third segment densely clothed with recumbent cinereous pubescence; pygidium without a median carina at apex. Prosternum feebly, irregularly striolate, finely and sparsely punctate, and sparsely clothed with short, inconspicuous hairs; prosternal lobe broadly rounded in front, broadly arcuately emarginate at middle, and strongly declivous; prosternal process rather broad, sides feebly arcuately emarginate to behind the coxal cavities, where they are expanded, then abruptly narrowed to the apex, which is acute; sides of prosternum, metasternum and mesosternum more densely clothed with recumbent cinereous pubescence than rest of body. Hind tarsi three-fourths as long as tibiae, the first joint as long as the following three joints united. Anterior and middle tibiae slender, feebly arcuate, and subcylindrical, and more or less mucronate at the apex; posterior pair straight, strongly flattened, and with a series of stiff hairs on the outer margin. Tarsal claws similar on all feet, deeply cleft, the teeth about equal in width, the inner one slightly shorter than the outer one, and slightly turned inward.

Length, 11.5 mm.; width, 2.75 mm.

Type locality.—Reyes, Bolivia.

Type.—Cat. No. 26968, U.S.N.M.

Described from a unique specimen, probably a female, collected at the type locality during October, 1921.

AGRILUS BOLIVIENSIS, new species

Male.—Form small, slender, and moderately shining; head emerald-green in front, becoming aureus, reddish and brownish-cupreous on the occiput; pronotum green, with a purplish tinge; elytra black, with a feeble purplish reflection, and each elytron ornated with cinereous pubescence as follows: A small, sparsely clothed spot in basal depression; an oblong, feebly impressed spot near sutural margin at basal third; and a similar one near the apical third. Beneath piceous, with a strong aeneous and cupreous tinge, and more shining than above; legs aeneo-viridis, more or less cupreous, and the tarsi blackish. Antennae aeneo-viridis.

Head with the front rather narrow, nearly flat, the sides strongly arcuately expanded at vertex, front without depressions, but with a rather deep, narrow longitudinal groove on the occiput and vertex; surface coarsely, densely granulose, and feebly scabrous on the front, becoming feebly longitudinally rugose on the occiput, and without any distinct pubescence; epistoma narrow between the antennae, and deeply, arcuately emarginate in front; antennae rather short, not extending to middle of pronotum, and serrate from the fourth joint. Pronotum one and one-third times as wide as long, distinctly wider in front than behind, and widest near apical fourth; sides feebly rounded from apical angles to behind the middle, then more obliquely narrowed to near the posterior angles, where they are feebly expanded, when viewed from the side the two margins are feebly sinuate, separated anteriorly, and connected to each other near posterior angles; anterior margin deeply arcuately emarginate, with a broadly rounded median lobe; base strongly emarginate at the middle of each elytron, and the median lobe broadly rounded, and more or less truncate in front of scutellum; disk moderately convex, without any distinct median depressions, but with a shallow depression on each side along the lateral carina, which is not sharply defined, slightly arcuate, and extending from the posterior angle to the lateral margin at middle; surface densely, but not very coarsely rugose, the rugae more or less transverse on the disk, but becoming more irregular and obsolete toward the sides, the intervals densely granulose, with numerous fine punctures along the rugae, and without any conspicuous pubescence. Scutellum strongly transversely carinate, and strongly acuminate at the apex; surface finely and densely reticulate. Elytra slightly wider than pronotum at base; sides parallel for a short distance behind base, broadly arcuately constricted at middle, broadly expanded at apical third, then obliquely attenuate to the tips, which are separately acutely rounded, and rather coarsely dentate; sides of abdomen narrowly exposed above; disk feebly convex, and each elytron with a broad deep basal de-

pression, and an obsolete longitudinal depression along the sutural margin, which is slightly elevated posteriorly; surface rather densely and finely imbricate-punctate, and besides the cinereous pubescent spots, is sparsely clothed with very short inconspicuous hairs. Abdomen beneath finely and sparsely punctate, the punctures becoming denser and more or less connected to each other by striae on the basal segment, and sparsely clothed with rather long recumbent cinereous hairs, which become denser toward the sides; intervals finely and densely reticulate; first segment obsoletely flattened at middle; last segment broadly truncate and feebly emarginate at apex; vertical portion of the segments sparsely clothed with cinereous pubescence; pygidium without a median carina at apex. Prosternum finely, densely punctate, densely granulose, and sparsely clothed with moderately long semi-erect cinereous hairs; prosternal lobe broadly rounded in front and moderately declivous; prosternal process rather broad, the sides nearly parallel to the apex, which is subtruncate. Femora moderately robust, and not armed with teeth on the inner margin. Tibiae slender, anterior and middle pairs nearly straight and mucronate at apex; posterior pair straight, and strongly ciliate on outer margin near apex. Posterior tarsi three-fourths as long as the tibiae, and the first joint about equal in length to the following three joints united. Tarsal claws similar on all feet, deeply cleft at apex, the teeth about equal in length, and slightly turned inward.

Female.—Differs from the male in having the head slightly more convex, front aeneous, with a slight cupreous tinge, antennae aeneo-piceous, and the prosternum not as densely pubescent.

Length, 5 mm.; width, 1.2 mm.

Type locality.—Cavinas (Beni River), Bolivia.

Type, allotype and paratypes.—Cat. No. 26969, U.S.N.M.

Described from a large series of specimens, all of which were collected at the type locality during January and February, 1922, by William M. Mann and M. R. Lopez.

This seems to be a very common species and is very uniform in size and coloration. Some of the paratypes have the pronotum and elytra more purplish than in the type, but otherwise they are identical.

AGRILUS CAVINAS, new species

Male.—Form rather small, slender and feebly shining; head emerald green in front, brownish-cupreous or aeneo-cuperous on the occiput; pronotum and elytra olivaceous-green, with an obsolete purplish reflection, and each elytron ornated with a rather broad yellow pubescent vitta along the sutural margin, extending from the basal depression to the apex, and broadly interrupted at basal fourth, behind the middle, and at the apical fourth. Beneath aeneo-cupreous,

with a rather strong purplish tinge, and more shining than above; legs aeneo-viridis, and the tarsi blackish; antennae aeneous at base, becoming piceous toward apex.

Head with the front rather narrow, nearly flat, sides strongly arcuately expanded at vertex, and without distinct depressions; surface densely coarsely granulose, and coarsely scabrous on the front, becoming coarsely, longitudinally rugose on the occiput, and clothed with a few long recumbent cinereous hairs behind the epistoma; epistoma broadly, but not very deeply arcuately emarginate in front; antennae short, not reaching to midde of pronotum, and serrate from the fourth joint. Pronotum one and one-half times as wide as long, slightly wider in front than behind, and widest at apical third; sides feebly arcuately rounded from apical angles to behind the middle, then nearly parallel to the posterior angles, which are rectangular, when viewed from the side the lower margin is straight, the upper one extending obliquely from the anterior margin to the lower lateral margin at middle, and widely separated from it anteriorly; anterior margin feebly, arcuately emarginate, with a broadly rounded median lobe; base strongly emarginate at middle of each elytron, with a broadly rounded median lobe, which is broadly truncate in front of scutellum; disk moderately convex, with a round shallow median depression in front of scutellum, and on each side with a rather deep depression extending arcuately around the inner side of the lateral carina to the lateral margin at middle, the lateral carina broadly elevated, but not sharply distinct, and extending arcuately from the posterior angle to lateral margin near middle, but not connected to it; surface coarsely and densely rugose, the rugae more or less transverse on the disk, but becoming more irregular toward the sides, the intervals densely granulose, with numerous fine punctures along the rugae, and sparsely clothed with rather short cinereous hairs in the depressed areas. Scutellum strongly transversely carinate, and strongly acuminate at apex; surface finely and densely granulose. Elytra slightly wider than pronotum at base; sides parallel for a short distance behind base, broadly arcuately constricted at middle, broadly expanded at apical third, then obliquely narrowed to the tips, which are separately obtusely rounded, and strongly dentate; sides of abdomen narrowly exposed above; disk feebly convex, and each elytron with a broad, rather deep basal depression, and an obsolete longitudinal depression along the sutural margin, which is feebly elevated posteriorly; surface coarsely and densely imbricate-punctate, and densely, finely granulose. Abdomen beneath finely and sparsely punctate, the punctures more or less transversely connected by striae on the basal segment, very sparsely clothed with short recumbent

cinereous hairs, and with a more densely pubescent spot at the sides of the segments; intervals finely and densely reticulate; first segment convex at middle, and without any median depressions; last segment broadly rounded at apex; pygidium without a median carina at apex. Prosternum finely, densely punctate, and rather densely clothed with moderately long, semi-erect cinereous hairs; prosternal lobe broadly rounded in front, obsoletely emarginate at middle, and moderately declivous; prosternal process rather broad, the sides nearly parallel to the apex, which is broadly rounded. Femora robust, especially the posterior ones, and not armed with teeth on the inner margin. Tibiae slender; anterior and middle pairs with a small spine at apex, the former slightly arcuate; posterior pair straight, and strongly ciliate on outer margin on apical half. Posterior tarsi about three-fourths as long as the tibiae, the first joint equal in length to the following three joints united. Tarsal claws dissimilar; claws on anterior pair deeply cleft at apex, the teeth about equal in length, and not turned inward; middle and posterior claws cleft at middle, the inner tooth broad, short, and not turned inward.

Female.—Similar to the male, but differs from it in having the front of the head wider, sides more parallel, and more aeneo-cupreous, abdomen more acutely rounded at apex, and the tarsal claws on all the feet cleft at the middle, with the inner tooth rather broad, short, and not turned inward.

Length, 6 mm.; width, 1.5 mm.

Type locality.—Cavinas (Beni River), Bolivia.

Type, allotype and paratypes.—Cat No. 26970, U.S.N.M.

Described from eleven specimens, ten males and one female, all collected at the type locality during January, 1922.

The species is very constant in size, coloration and markings, with the exception that some of the paratypes have the pubescent spots on the elytra more whitish than the type. This species is named after one of the Indian tribes.

AGRILUS TAKANA, new species

Male.—Form rather small, slender and moderately shining; head aeneeo-viridis on the front, becoming purplish-black on the occiput; pronotum purplish-black; elytra bottle-green, with a feeble purplish-black reflection, and each elytron ornated with cinereous pubescence as follows: A small spot in the basal depression; a narrow impressed vitta along suture, extending from basal fourth to middle, with a small obselete spot between its posterior extremity and the lateral margin; and a sparsely clothed area covering the apical fourth. Beneath aeneo-piceous, and more shining than above; legs

more greenish, and the tarsi piceous; antennae aeneous at base, becoming purplish toward apex.

Head with the front rather wide, nearly flat, the sides nearly parallel, and without any distinct depressions; surface densely, coarsely granulose, and densely, coarsely rugose or scabrous on the front, becoming coarsely longitudinally rugose on the occiput, and very sparsely clothed with rather long cinereous hairs behind the epistoma; epistoma wide between the antennae, and broadly, but not deeply emarginate in front; antennae rather short, reaching to middle of pronotum, and serrate from the fourth joint. Pronotum one and one-fourth times as wide as long, distinctly wider in front than behind, and widest along apical half; sides nearly parallel to middle, then arcuately narrowed to near the posterior angles, where they are feebly expanded, when viewed from the side the two margins are strongly sinuate, separated anteriorly, and connected to each other at basal third; anterior margin strongly arcuately emarginate, with a broadly rounded median lobe; base feebly emarginate at middle of each elytron, and with a broadly rounded median lobe; disk moderately convex, with two round, moderately deep median depressions, and more or less broadly depressed along the sides and at base, the lateral carina rather sharply defined, straight, and extending from the posterior angle to near the middle; surface rather irregularly rugose, the intervals finely, irregularly punctate, and finely, densely granulose, and sparsely clothed with cinereous pubescence in the depressed areas at sides. Scutellum strongly transversely carinate, and strongly acuminate at apex; surface finely and densely reticulate. Elytra distinctly wider than pronotum at base; sides parallel for a short distance behind base, broadly arcuately constricted at basal third, arcuately expanded at apical third, then obliquely attenuate to the tips, which are separately obtusely rounded, and strongly, regularly dentate; sides of abdomen covered by elytron; disk feebly convex, and each elytron with a broad, rather deep basal depression, and with an obsolete longitudinal depression along sutural margin, the depression more deeply impressed from basal fourth to middle, and the suture feebly elevated posteriorly; surface coarsely and densely imbricate-punctate. Abdomen beneath sparsely, coarsely and obsoletely punctate, becoming more or less transversely striolate at sides of basal segment, sparsely clothed with short recumbent hairs, and with a more densely pubescent spot at sides of third segment; intervals finely and densely reticulate; first segment feebly convex, and sparsely clothed with long, fine, erect hairs at the middle; last segment broadly rounded at apex, with the apical groove rounded at middle; vertical portion of the segments not conspicuously pubescent; pygidium without a median carina at apex. Prosternum coarsely, rather densely scabrous, and densely clothed with very long, erect, inconspicuous hairs;

prosternal lobe broadly rounded in front, deeply arcuately emarginate at middle, and feebly declivous; prosternal process rather broad, the sides parallel to the apex, which is broadly rounded. Femora rather slender, the anterior pair with a few obsolete teeth on the inner margin near apex. Tibiae slender, anterior and middle pairs feebly arcuate, and armed with a sharp curved spine on inner margin at apex; posterior pair straight, feebly flattened, and strongly ciliate on outer margin on apical half. Posterior tarsi about as long as the tibiae, and the first joint as long as the following three joints united. Tarsal claws dissimilar; claws on anterior and middle feet deeply cleft near apex, the inner tooth slender, not quite as long as the outer one, and not turned inward; claws on posterior feet cleft at middle, the inner tooth broad and very short.

Female.—Differs from the male in being larger; head more convex, broader in front, sides more parallel, and the color dark brown, with an aeneous tinge; median parts of first abdominal segment and prosternum without long erect hairs; and the tarsal claws broadly cleft at middle on all the feet, the inner tooth very broad, short, and not turned inward.

Length, 5.75–7.5 mm.; width, 1.4–1.9 mm.

Type locality.—Rurrenabaque (Beni River), Bolivia.

Type and allotype.—Cat. No. 26971, U.S.N.M.

Described from two examples, male and female, collected at the type locality during October, 1921. Named after one of the Indian tribes.

AGRILUS TUMUPASAENSIS, new species

Male.—Form moderately large, elongate and feebly shining; head olivaceous-green on the front, becoming cupreous on the occiput; pronotum aeneo-brunneus, with a feeble greenish or purplish reflection; elytra bottle-green, with a distinct purplish tinge, and each elytron ornated with pale yellow recumbent pubescence arranged as follows: A rather broad vitta extending from the basal depression along the suture to middle, with an obsolete spot between its posterior extremity and the lateral margin; two oblong spots placed transversely at apical third, the sutural one slightly in advance of the lateral one; and a rather broad vitta along the suture at apex. Beneath brunneo-cupreous, more shining than above, and more or less ornated with whitish pubescent areas.

Head with the front rather narrow, nearly flat, sides feebly arcuately expanded at vertex, without any depressions on the front, but with a narrow longitudinal groove on the vertex and occiput; surface coarsely, densely scabrous, or irregularly rugose on the front, becoming coarsely, longitudinally rugose on the occiput, and sparsely clothed with rather long recumbent hairs on the front; epistoma

broadly, but not very deeply arcuately emarginate in front; antennae rather long, extending beyond middle of pronotum and serrate from the fourth joint. Pronotum about one and one-fourth times as wide as long, distinctly wider in front than behind, and widest at apical angles; sides obliquely narrowed from apical angles to the base, where they are feebly expanded, when viewed from the side the lower margin is nearly straight, the upper one sinuate, strongly arcuate anteriorly and connected to the lower margin at posterior angle; anterior margin deeply arcuately emarginate, with a broadly rounded median lobe; base feebly sinuate on each side, with a broadly rounded median lobe, which is truncate in front of scutellum; disk moderately convex, with a rather broad, deep median depression extending from anterior margin to base, and on each side with a sinuate depression extending from the base along inner side of lateral carina to anterior angle, the lateral carina sharply defined, straight, and extending from base to near the middle, where it is slightly arcuate; surface coarsely and densely rugose, the rugae more or less transverse on the disk, but becoming more obsolete and irregular toward the sides, finely and rather densely punctate between the rugae, and rather densely clothed with moderately long, yellowish hairs in the depressed areas. Scutellum strongly transversely carinate, and strongly accuminate at apex; surface densely and finely reticulate. Elytra distinctly wider than pronotum at base; sides feebly, arcuately expanded for a short distance behind the humeral angles, broadly arcuately constricted near middle, feebly expanded at apical third, then obliquely attenuate to the tips, which are strongly, coarsely dentate, the median tooth of each elytron being the longest; sides of abdomen narrowly exposed above; disk feebly convex, and each elytron with a broad, deep basal depression, and with a more or less distinct longitudinal depression along the sutural margin, which is feebly elevated posteriorly; surface finely, densely imbricate-punctate, and besides the yellowish pubescent areas, is sparsely clothed with very short inconspicuous hairs. Abdomen beneath sparsely, finely punctate, the punctures becoming denser and more or less connected toward the sides, very sparsely clothed with short recumbent hairs, and with a more densely pubescent spot at the sides of the segments; intervals nearly smooth; first segment convex at middle, and without any median depression; last segment rather acutely rounded at apex; vertical portion of the segments rather densely clothed with recumbent yellowish pubescence; pygidium without a median carina at apex. Prosternum sparsely, finely punctate, densely, coarsely granulose, and sparsely clothed with moderately long semi-erect cinereous hairs; prosternal lobe broadly rounded in front, obsoletely emarginate at middle, and feebly de-

clivous; prosternal process rather wide, the sides parallel to behind the coxal cavities, then abruptly narrowed to the apex, which is acute. Femora moderately robust, and with a few obsolete teeth on the inner margin near apex. Tibiae slender, anterior and middle pairs feebly arcuate, and armed with a sharp curved spine on inner margin at apex; posterior pair straight, subcylindrical, and strongly ciliate on outer margin on apical half. Posterior tarsi seven-ninths as long as the tibiae, and the first joint about equal in length to the following three joints united. Tarsal claws dissimilar; claws on anterior and middle tarsi deeply cleft at apex, the two teeth slender and about equal in length; anterior claws cleft at middle, the inner tooth broad, short, and not turned inward.

Female.—Differs from the male in having the head more convex, slightly wider, sides more parallel, the front more sparsely, coarsely punctured, and entirely reddish-cupreous, pronotum and elytra more greenish, the pubescence more whitish, and the two posterior pubescent spots along suture connected, abdomen acutely rounded at apex, and the tarsal claws broadly cleft at middle on all feet, the inner tooth broad, short, and not turned inward.

Length, 8.5–9.5 mm.; width, 2–2.1 mm.

Type locality.—Tumupasa, Bolivia.

Type, allotype and paratypes.—Cat. No. 26972, U.S.N.M.

Described from six specimens, five males and one female, collected at the type locality during December, 1921.

In some of the paratypes the dorsal surface is more purplish and the pubescence more whitish, otherwise they agree with the type.

AGRILUS GORAI, new species

Female.—Form rather small, slender, and moderately shining; above black, with an obsolete purplish reflection, the head more or less aeneous in front, and each elytron ornated with cinereous pubescence as follows: A sparsely clothed area surrounding the scutellum and filling the basal depression; a wide impressed vitta, extending along the sutural margin from basal fourth to middle, and then transversely to the lateral margin; and a large spot covering the entire apical third. Beneath aeneo-piceous, with the legs more or less cupreous, and the tarsi blackish.

Head with the front wide, feebly convex, the sides feebly expanded on vertex and occiput, and with a broad shallow depression extending from the occiput to epistoma, the depression more or less obsolete on the front, but becoming more distinct on the vertex; surface densely, coarsely granulose, and coarsely, irregularly reticulate on the front, becoming coarsely longitudinally rugose on the occiput, and with only a few cinereous hairs behind the epistoma;

epistoma rather wide between the antennae, and broadly feebly arcuately emarginate in front; antennae rather long, extending to middle of the pronotum, and serrate from the fourth joint. Pronotum only slightly wider than long, distinctly wider in front than behind, and widest at apical angles; sides obliquely narrowed from the apical angles to the base, and when viewed from the side the two margins are strongly sinuate, separated anteriorly, and connected to each other at the basal fourth; anterior margin deeply arcuately emarginate, with a broadly rounded median lobe; base rather strongly emarginate at middle of each elytron, with a broadly rounded median lobe, which is feebly arcuately emarginate in front of scutellum; disk moderately convex, with two round shallow median depressions, and rather deeply depressed on each side along lateral margin, the lateral carina not very sharply defined, nearly straight, and extending from the posterior angle to basal fourth; surface finely and densely rugose, the rugae more or less concentrical on the disk, the intervals densely granulose, with numerous fine punctures along the rugae, and clothed with a few short cinereous hairs on the depressed areas along sides. Scutellum strongly transversely carinate, and strongly acuminate at apex; surface finely and densely reticulate. Elytra slightly wider than pronotum at base; sides parallel for a short distance behind base, broadly and strongly arcuately constricted at middle, feebly arcuately expanded at apical third, then obliquely attenuate to the tips, which are subtruncate, strongly dentate, with the median tooth of each elytron much longer than the others; disk feebly convex, and each elytron with a very broad, moderately deep basal depression, and an obsolete longitudinal depression along the sutural margin, the depression more deeply impressed from basal fourth to middle, and the suture feebly elevated posteriorly; sides of abdomen broadly exposed above; surface coarsely and densely imbricate-punctate, and besides the cinereous pubescent areas, is sparsely clothed with short inconspicuous hairs. Abdomen beneath sparsely, finely punctate, the punctures becoming denser and feebly striolate toward the sides, very sparsely clothed with short recumbent cinereous hairs, and with a slightly denser pubescent spot at the sides of the segments; intervals obsoletely reticulate; first segment convex at middle, without any median depression; last segment acutely rounded at apex; vertical portion of first segment with a densely pubescent spot; pygidium without a median carina at apex. Prosternum sparsely finely scabrous, more or less rugose, and very sparsely clothed with short recumbent cinereous hairs; prosternal lobe broadly rounded in front, obsoletely emarginate at middle, and moderately declivous; prosternal process rather broad, the sides nearly parallel

to apex, which is broadly rounded. Femora not armed with teeth on the inner margin. Tibiae slender, the anterior pair feebly arcuate and slightly mucronate at the apex. Posterior tarsi about three-fourths as long as the tibiae, and the first joint about as long as the following three joints united. Tarsal claws similar on all feet, cleft at middle, the inner tooth broad, very short, and not turned inward.

Length, 6.25 mm.; width, 1.4 mm.

Type locality.—Tumupasa, Bolivia.

Type.—Cat. No. 26973, U.S.N.M.

Described from a unique female collected at the type locality during December, 1921. This species is named after one of the Indian tribes.

AGRILUS BENIENSIS, new species

Male.—Form moderately large, rather slender, strongly acuminate posteriorly, and subopaque; head bluish-green on the front, becoming aeneo-brunneus on the occiput; pronotum aeneo-brunneus, the aeneous tinge becoming more distinct toward the sides; elytra brunneo-purpureous, with feeble aeneous reflection, and each elytron ornated with a narrow pale yellow pubescent vitta, extending along suture from basal depression to apex. Beneath aeneo-cupreous, more shining than above; legs more or less greenish, and the tarsi piceous; antennae with the basal joints aeneous, and the exterior ones piceous above, and reddish-cupreous beneath.

Head with the front narrow, nearly flat, the sides strongly arcuately expanded at vertex, and with an obsolete longitudinal depression extending from the occiput to epistoma; surface densely, coarsely granulose, and coarsely scabrous on the front, becoming coarsely longitudinally rugose on the occiput, and very sparsely clothed with cinereous hairs behind the epistoma; epistoma narrow between the antennae, and deeply arcuately emarginate in front; antennae rather long, extending slightly beyond middle of pronotum and serrate from the fourth joint. Pronotum only slightly wider than long, distinctly wider in front than behind, and widest near apical angles; sides arcuately narrowed from anterior angles to the base, where they are feebly expanded, when viewed from the side the two margins are rather strongly sinuate, separated anteriorly, and connected to each other at posterior angle; anterior margin deeply arcuately emarginate, with a broadly rounded median lobe; base strongly emarginate at middle of each elytron, with a broadly rounded median lobe, which is broadly truncate in front of scutellum; disk moderately convex, with two round, rather deep median depressions, and on each side with rather deep depression extending from the base along inner side of lateral carina to the apical angle,

the lateral carina sharply defined, extending arcuately from the posterior angle to the lateral margin at middle; surface feebly irregularly rugose, finely, densely granulose, and finely, deeply and irregularly punctate, and clothed with a few scattered cinereous hairs. Scutellum strongly transversely carinate, and strongly acuminate at apex; surface finely and densely reticulate. Elytra slightly wider than pronotum at base, and strongly acuminate posteriorly; sides feebly arcuately expanded behind the humeral angles for a short distance, broadly arcuately constricted near middle, feebly broadly expanded at apical third, then obliquely attentuate to the tips, which are separately acutely rounded, strongly dentate, and each elytron terminating in a short spine at the middle; sides of abdomen narrowly exposed above; disk feebly convex, and each elytron with a broad, moderately deep basal depression, and with a moderately deep longitudinal depression along the sutural margin, which is feebly elevated posteriorly; surface rather finely and very densely imbricate-punctate. Abdomen beneath finely and rather densely punctate, and more or less transversely striolate, sparsely clothed with short recumbent cinereous hairs, and with a slightly denser pubescent spot at the sides of the segments; intervals finely obsoletely reticulate; first segment strongly compressed laterally, with a strongly elevated, transversely arcuate median carina at apex; last segment broadly subtruncate at apex, with the apical groove feebly emarginate at middle; vertical portion of the segments not conspicuously pubescent; pygidium with a strongly projecting carina at apex, the carina truncate at tip. Prosternum densely, coarsely scabrous, and sparsely clothed with moderately long semi-erect cinereous hairs; posternal lobe broadly rounded in front, and moderately declivous; prosternal process rather broad, sides feebly arcuately emarginate to behind the coxal cavities, where they are expanded, then abruptly narrowed to the apex, which is acute. Femora robust, the anterior pair with a few obsolete teeth on the inner margin near apex. Tibae slender; anterior pair strongly arcuate, with a sharp curved spine on inner margin at apex; middle pair feebly arcuate, with a similar tooth at apex; posterior pair straight, more or less flattened, and feebly expanded at apex. Posterior tarsi two-thirds as long as the tibiae, and the first joint about equal in length to the following three joints united. Tarsal claws dissimilar, anterior and middle claws feebly cleft at apex, forming two short teeth of equal length; posterior claws cleft near middle, the inner tooth slender, not quite as long as outer one, and not turned inward.

Female.—Differs from the male in having the head a little more convex, and the surface a little more coarsely punctate, pubescence on elytra more cinereous, abdomen with the first segment regularly

convex, the sides not as densely pubescent, and the claws similar on all feet, cleft near the middle, the inner tooth slender, not quite as long as the outer one, and not turned inward.

Length, 5.7–7.25 mm.; width, 1.2–1.4 mm.

Type locality.—Cachuela Esperanza (Beni River), Bolivia.

Type, allotype, and paratype.—Cat. No. 26974, U.S.N.M.

Described from three specimens, one male and two females, collected at the type locality during March, 1922.

The paratype differs from the allotype in having the pubescence on the elytra pale yellow, and the carina on pygidium not projecting beyond the tip.

AGRILUS MANNI, new species

Female.—Form large, robust and subopaque; head purpureous, with a distinct cupreous tinge; pronotum and elytra purpureous, with a feeble olivaceous reflection, and each elytron with a broad, obsolete pubescent vitta along the suture; beneath brunneus, with purplish or cupreous reflections, and more or less ornated with yellowish-white pubescent areas.

Head with the front rather wide, nearly flat, sides broadly arcuately expanded, with a broad, deep concavity on the vertex and occiput, composed of three depressions arranged in the form of a triangle, of which the posterior one is the deepest, the depression extending transversely to the lateral margins; there is also a broad shallow longitudinal depression behind the epistoma; surface coarsely, irregularly and rather densely punctate, the punctures more or less confluent and forming irregular rugae, the intervals obsoletely granulose, and clothed with a few very short cinereous hairs behind the epistoma; epistoma narrow between the antennae, feebly arcuately emarginate in front, with a broad, obsolete tooth on each side of the emargination; antennae short, extending a little beyond the anterior margin of pronotum, and serrate from the fourth joint. Pronotum one and one-third times as wide as long, apex and base nearly equal in width, and widest at middle; sides rather strongly arcuately rounded; when viewed from the side the upper margin is sharply defined and feebly sinuate, and the lower one represented by an abbreviated short carina connected to the upper margin at middle and not extending to the front margin; anterior margin feebly arcuately emarginate, with an obsolete broadly rounded merian lobe; base broadly arcuately emarginate from posterior angles to scutellum, in front of which the lobe is subtruncate; disk moderately convex, with a broad, moderately deep median depression, extending from anterior margin to base, and becoming deeper posteriorly, and on each side with a rather deep depression extending along inner side of lateral carina to the lateral margin

at middle, the lateral carina broadly rounded, not sharply defined on top, and extending from the base near posterior angle parallel with the margin to near middle, then turning arcuately to the lateral margin, with which it is obsoletely connected; surface coarsely and densely rugose, the rugae more or less transverse on the disk, but becoming more irregular toward the sides, finely and rather densely punctate between the rugae, and sparsely clothed with recumbent pubescence, which is short on the disk, but becoming longer, denser and more yellowish toward the anterior angles. Scutellum not transversely carinate, nor strongly acuminate at apex; surface finely and densely reticulate. Elytra as wide as pronotum at base; sides parallel and feebly sinuate for a short distance behind base, broadly arcuately constricted near middle, feebly expanded at apical third, then feebly attenuate to the apex, which is deeply arcuately emarginate, obsoletely dentate, and each elytron terminating in a long acute spine at the lateral margin; sides of abdomen broadly exposed above; disk feebly convex, and each elytron with a rather shallow, broad basal depression, and a broad obsolete longitudinal depression along the sutural margin, which is scarcely elevated posteriorly; surface densely and coarsely imbricate-punctate at the sides, but the punctuation becoming finer in the sutural depression. Abdomen beneath densely, finely, but not deeply punctate, the punctures connected transversely by obsolete striae on the basal segments, very sparsely clothed with short inconspicuous hairs, and with a large densely pubescent spot at the sides of the segments; intervals obsoletely granulose; first segment convex at middle, and without any median depression; last segment broadly rounded at apex; vertical portion of the first and second segments densely clothed with yellowish pubescence; pygidium without a median carina at apex. Prosternum coarsely, densely rugose, densely, irregularly punctate, and rather densely clothed with short recumbent cinereous hairs; prosternal lobe broadly rounded in front, obsoletely emarginate at middle, and strongly declivous; prosternal process nearly parallel to behind the coxal cavities, then strongly attenuate to the apex, which is rather acutely rounded. Femora not armed with teeth on inner margin. Tibiae slender, the anterior pair feebly arcuate and rather strongly mucronate at the apex. Posterior tarsi longer than the tibiae, and the first joint slightly longer than the following three joints united. Tarsal claws similar on all feet, cleft at middle, the inner tooth broad, only one-half as long as the outer tooth, and not turned inward.

Length, 11 mm.; width, 2.5 mm.

Type locality.—Rosario (Lake Rogagua), Bolivia.

Type.—Cat. No. 26975, U.S.N.M.

Described from a unique female collected at the type locality during November, 1921.

AGRILUS AURITUS Chevrolat

Agrilus auritus CHEVROLAT Silbermann's Rev. Ent., vol. 5, 1838, pp. 93–94.

One example collected at Rio Colorado, Bolivia, during September, 1921.

This beautiful species is quite distinct from most of the species of *Agrilus*. It is much flattened above, elytra nearly parallel, black, with the front of head and sides of the pronotum reddish, the antennae strongly pectinate, and should probably be taken as the type of a new genus.

GERALIUS FURCIVENTRIS (Chevrolat)

Stenogaster furciventris CHEVROLAT, Silbermann's Rev. Ent., vol. 5, 1838, pp. 88–89.

Two specimens of this species were collected at Rosario (Lake Rogagua), during November, 1921.

PARAGRILUS PURPUREUS, new species

Male.—Narrowly elongate, and moderately shining; above black, with a strong purplish tinge; beneath piceous with a feeble aeneous or cupreous reflection.

Head feebly convex, not flattened behind the epistoma, but with a round, moderately deep depression on the front, and a feeble longitudinal groove on the vertex, the groove not extended on the occiput; surface glabrous, coarsely and densely granulose, with the punctures only obsoletely indicated; antennal cavities nearly contiguous; epistoma broadly, but feebly arcuately emarginate in front. Pronotum moderately, regularly convex, slightly wider than long, feebly narrower in front than behind; sides when viewed from above, feebly arcuately expanded from anterior angles to apical fourth, then nearly parallel to the posterior angles, which are obtusely rounded; anterior margin bisinuate, with the median lobe broadly rounded; base deeply, arcuately emarginate on each side, with the median lobe strongly produced, broadly truncate, and feebly emarginate in front of scutellum; surface with a broad, shallow depression, extending obliquely from near the lateral margin at middle to the elytral lobe, then transversely along the base, and more deeply depressed in front of scutellum, densely, coarsely granulose, and rather sparsely obsoletely punctate, the punctures large, very shallow, denser toward the sides, and forming more or less distinct transverse or broadly arcuate rugae on the disk. Scutellum triangular, acute at apex, with the surface densely and coarsely granulose. Elytra with the sides broadly rounded behind the humeral angles, strongly, broadly arcu-

ately constricted at middle, then broadly arcuately expanded at apical third, and finally obliquely attenuate to the tips, which are conjointly broadly subtruncate, with the lateral margins entire; humeri moderately developed; each elytron with a rather broad, deep basal depression, with a distinct feebly arcuate lateral carina extending from the humerus to middle of elytron, and with the suture strongly elevated from basal fourth to apex; surface coarsely, densely granulose, with a few obsolete punctures, which have a tendency of forming rows on the disk, and clothed with a few very short inconspicuous hairs. Abdomen beneath finely, densely granulose, with a few obsolete punctures intermixed, and sparsely clothed with very short, inconspicuous hairs.

Length, 4.5 mm.; width, 1.1 mm.

Type locality.—Rio Mapiri (near mouth), Bolivia.

Other localities.—Huachi (Beni River), Bolivia.

Type and paratypes.—Cat. No. 26976, U.S.N.M.

Described from six specimens, the type and two paratypes collected during September, 1921, near the mouth of the Rio Mapiri, and three paratypes collected during the same month at Huachi, on the Beni River.

PARAGRILUS OPACIPENNIS, new species

Male.—Narrowly elongated; head and pronotum dark aeneous, the latter with the median part more aureo-aeneus, and moderately shining; scutellum and elytra black, strongly opaque, with the reliefs more shining; beneath black, and more shining than above.

Head feebly convex, not flattened behind the epistoma, but with a rather broad, moderately deep longitudinal groove extending from occiput to middle of front; surface glabrous, densely, obsoletely granulose, and rather densely. coarsely punctate, the punctures shallow, irregularly placed, and becoming somewhat confluent and transversely rugose behind the epistoma; antennal cavities nearly contiguous; epistoma broadly, but feebly arcuately emarginate in front. Pronotum feebly, regularly convex, one and one-third times as wide as long, apex and base about equal in width, and widest at apical third; sides when viewed from above arcuately expanded from anterior angles to apical third, where they are obtusely rounded, then strongly obliquely attenuate to the posterior angles, which are obtusely rounded; anterior margin bisinuate, with the median lobe broadly rounded; base deeply arcuately emarginate on each side, with the median lobe moderately produced and broadly subtruncate in front of scutellum; surface with two broad, rather deep depressions on each side, one near the lateral margin at apical third, the other in front of the basal emargination, densely, coarsely granulose, especially near the posterior angles, and very strongly, ir-

regularly transversely rugose on the disk. Scutellum triangular, acute at apex, with the surface densely and coarsely granulose. Elytra with the sides slightly rounded behind the humeral angles, feebly broadly arcuately constricted at middle, then broadly arcuately expanded at apical fourth, and finally arcuately attenuate to the tips, which are separately broadly rounded, with the lateral margins entire; humeri rather strongly developed; each elytron with a broad, moderately deep basal depression, with a short straight lateral carina extending from humerus to middle of elytron, and with the suture elevated from basal third to apex; surface opaque, densely, coarsely granulose, with numerous short transverse elevations, which are irregularly placed and more shining than the intervals. Abdomen beneath densely and rather coarsely granulose, and rather densely punctate, the punctures large, very shallow, and nearly obsolete, and sparsely clothed with very short, inconspicuous hairs.

Length, 3.75 mm.; width, 1 mm.

Type locality.—Rosario (Lake Rogagua), Bolivia.

Type.—Cat. No. 26977, U.S.N.M.

Described from a unique male collected at the type locality during November, 1921.

PARAGRILUS HOLOMELAS, new species

Narrowly elongate, uniformly piceous above and beneath, and strongly shining.

Head feebly convex and only obsoletely flattened behind the epistoma, with a round, moderately deep depression on the front, and a broad longitudinal groove on the vertex, the groove not extended on the occiput; surface densely, coarsely granulose, with a few large, obsolete punctures intermixed, the punctures shallow, irregular in shape, and becoming more closely placed behind the epistoma, where the surface is also rather densely clothed with short, recumbent, scale-like cinereous hairs; antennal cavities narrowly separated on the front; epistoma broadly, deeply arcuately emarginate in front. Pronotum moderately, regularly convex, slightly wider than long, apex and base about equal in width, and widest at apical third; sides when viewed from above arcuately expanded from anterior angles to apical third, where they are broadly rounded, then feebly obliquely attenuate to the posterior angles, which are rectangular; anterior margin bisinuate, with the median lobe broadly rounded; base strongly angularly emarginate on each side, with the median lobe moderately produced, and broadly subtruncate in front of scutellum; surface with a broad, very deep depression, extending obliquely from near the apical angles to the basal emargination, then transversely along the base, the groove more deeply impressed at the posterior angles, in front of which is a broadly rounded eleva-

tion, nearly smooth, only indistinctly punctate and granulose. Scutellum triangular, acute at apex, with the surface obsoletely granulose. Elytra with the sides broadly rounded behind the humeral angles, strongly, broadly, arcuately constricted at middle, then broadly arcuately expanded at apical third, and finally obliquely attenuate to the tips, which are separately broadly rounded, with the lateral margins entire; humeri moderately developed; each elytron with a broad, rather shallow basal depression, with a distinct feebly sinuate lateral carina extending from the humeral angle to a little beyond the middle of elytron, and with the suture strongly elevated from basal fourth to apex; surface coarsely densely granulose, and feebly transversely rugose on the disk, with a few obsolete punctures, which have a tendency of forming rows on the disk. Abdomen beneath densely, finely granulose, with a few obsolete punctures intermixed, and sparsely clothed with very short inconspicuous hairs.

Length, 3.5 mm.; width, 1 mm.

Type locality.—Rurrenabaque (Beni River), Bolivia.

Type.—Cat. No. 26978, U.S.N.M.

Described from a unique specimen, probably a female, collected at the type locality during December, 1921.

PARAGRILUS PULCHELLUS, new species

Male.—Rather broadly elongate, and moderately shining; head aeneous; pronotum and scutellum aeneo-cupreous, the former with the disk purplish, and the median part of a more or less dark bluish color; elytra dark blue, with a strong purplish tinge in certain lights; beneath piceous, with a feeble æneous reflection, and more shining than above.

Head moderately convex, distinctly flattened behind the epistoma, with a longitudinal groove extending from the occiput to flattened area in front, the groove rather obsolete on the occiput, and more broadly and deeply impressed on front; surface coarsely, densely granulose, and rather densely coarsely punctate, the punctures very shallow, irregularly placed, and becoming denser on the flattened area behind epistoma, where the surface is densely clothed with short, recumbent, scale-like yellow hairs; antennal cavities separated on the front by about the diameter of the cavities; epistoma broadly, deeply, arcuately emarginate in front. Pronotum feebly convex, rather uneven, one and one-third times as wide as long, apex and base about equal in width, and widest just behind the middle; sides when viewed from above feebly arcuately expanded to just behind the middle, then arcuately emarginate and feebly attenuate to posterior angles, which are rectangular; anterior margin bisinuate, with the median lobe broadly rounded; base abruptly, but feebly ar-

cuately emarginate on each side, with the median lobe moderately produced, and broadly rounded in front of scutellum; surface with a broad, rather deep depression, extending from near the lateral margin at middle, obliquely backward and covering the entire postero-median part, the depression more deeply depressed posteriorly, with the sides abruptly marked, densely, coarsely granulose, and strongly, irregularly, transversely rugose on the disk. Scutellum triangular, acute at apex, with the surface coarsely and densely granulose. Elytra with the sides moderately expanded behind the humeral angles, feebly, broadly arcuately constricted near basal third, then broadly arcuately expanded at apical third, and finally arcuately attenuate to the tips, which are separately broadly rounded, with the lateral margins entire; humeri feebly developed; each elytron with a broad, very shallow basal depression, with a short, straight, strongly elevated carina extending from the humerus to middle of elytron, and with the suture feebly elevated posteriorly; surface coarsely, densely granulose, obsoletely rugose, with few obsolete punctures, which have a tendency of forming rows on the disk, and sparsely clothed with very short, inconspicuous hairs. Abdomen beneath finely, densely granulose, with a few obsolete punctures intermixed, and sparsely clothed with very short inconspicuous hairs.

Length, 4.75 mm.; width, 1.5 mm.

Type locality.—Huachi (Beni River), Bolivia.

Type.—Cat. No. 26979, U.S.N.M.

Described from a unique male, collected at the type locality during September, 1921.

PACHYSCHELUS CAVINAS, new species

Female.—Broadly cuneiform, distinctly longer than wide, broadly rounded in front, strongly attenuate posteriorly, distinctly narrower behind than in front, and the surface glabrous and moderately shining; head, pronotum, and scutellum green, with a feeble aeneous tinge; elytra dark greenish-blue, with a distinct violaceous reflection, especially toward the sides; beneath piceous, and more shining than above.

Head feebly and evenly convex, deeply embedded in the prothorax, without any depression, but with a very narrow, obsolete groove, which is only indicated on the front; surface glabrous, nearly smooth on the occiput, but becoming finely and densely granulose toward the epistoma, and with a few coarse, irregularly placed punctures intermixed. Pronotum nearly flat, strongly declivous at anterior angles, four times as wide as long at middle, very much narrower in front than behind, and widest at base; sides strongly obliquely attenuate (feebly arcuate) from base to anterior angles,

which are acutely angulated; anterior margin broadly and deeply arcuately emarginate; base transversely sinuate, acutely emarginate at elytral lobes, and broadly truncate in front of scutellum; posterior angles acute, projecting slightly beyond the humeral angles of elytra and fitting closely to them; surface glabrous, sparsely and very irregularly punctate, the punctures finer on the median part, but becoming coarser toward the sides; intervals nearly smooth on the disk, and finely, densely granulose along the lateral margins. Scutellum wider than long, glabrous, smooth, with the anterior angles rectangular. Elytra as wide as pronotum at base, and widest at basal third; humeral angles broadly rounded; sides arcuately expanded to basal third, where they are broadly rounded, then obliquely attenuate to near the tips, which are conjointly rather narrowly rounded, the lateral margins strongly serrate, and when viewed from the side are nearly straight, except for an abrupt sinuation for the posterior femora; each elytron with a broad shallow depression at base, and a very broad, deeper one behind the humerus, broadly flattened at the lateral margin and extending forward to the humeral angle; surface with more or less regular rows of fine, irregularly placed punctures, which are distinct on the basal region, but becoming obsolete posteriorly, and with the intervals smooth. Abdomen beneath moderately convex, finely, sparsely, and obsoletely punctate, and clothed with a few very short, inconspicuous hairs; intervals finely and obsoletely reticulate; last segment strongly, narrowly produced, and very deeply triangularly emarginate at apex, with four sharp teeth arranged in pairs obliquely on each side of the emargination, the anterior pair shorter than the apical pair, the ventral surface with a moderately deep, longitudinal depression, extending from the apex to near the middle. Elytral epipleura narrow. Metasternum sparsely, coarsely punctate, and feebly, broadly, arcuately emarginate in front. Prosternum feebly arcuately emarginate in front, the surface nearly glabrous, smooth, and with only a few fine obsolete punctures; prosternal process four times as wide as the coxal cavities, sides feebly rounded, and broadly rounded or subtruncate at apex.

Length, 3.1 mm.; width, 2.25 mm.

Type locality.—Canamina, Bolivia.

Type and paratype.—Cat. No. 26980, U.S.N.M.

Described from two females collected at the type locality during January, 1922.

PACHYSCHELUS JUCUNDUS (Kirsch)

Brachys jucundus Kirsch, Berl. Ent. Zeit., vol. 17, 1873, p. 361.

One specimen collected at Rosario (Lake Rogagua), during the latter part of October, 1921, by M. R. Lopez.

PACHYSCHELUS VIRIDESCENS (Kirsch)

Brachys viridescens Kirsch, Berl. Ent. Zeit., vol. 17, 1873, pp. 359-360.

A single example of this species was collected near the mouth of the Mapiri River, Bolivia, during September, 1921.

PACHYSCHELUS NUDUS, new species

Male.—More narrowly cuneiform than *cavinas*, considerably longer than wide, broadly rounded in front, strongly attenuate posteriorly, distinctly narrower behind than in front, and the surface glabrous and moderately shining; head and pronotum aureo-viridis, the latter with a large, broadly triangular fuscous spot, the sides of the spot extending from anterior margin at middle, obliquely backward to the posterior angles; scutellum fuscous; elytra greenish-black; beneath piceous, and more shining than above.

Head feebly convex, deeply embedded in the prothorax, broadly but not deeply depressed on the front, and with a narrow obsolete longitudinal groove, extending from vertex to near the epistoma, where it terminates in a small obsolete triangular depression; surface densely and coarsely granulose, with a few coarse, irregularly placed punctures intermixed. Pronotum feebly convex, three times as wide as long at middle, much narrower in front than behind, and widest at base; sides strongly obliquely arcuate from base to anterior angles, which are acutely angulated; anterior margin broadly and deeply arcuately emarginate; base transversely sinuate, acutely emarginate at elytral lobes, and feebly broadly emarginate in front of scutellum; posterior angles acute, projecting slightly beyond the humeral angles of elytra and fitting closely to them; surface glabrous, sparsely and irregularly punctate, the punctures rather fine and more obsolete on the disk, becoming coarser at the sides, the intervals nearly smooth on the median part, but densely, finely granulose toward the lateral margins. Scutellum wider than long, glabrous, obsoletely granulose, with the anterior angles rectangular. Elytra about as wide as pronotum at base; humeral angles broadly rounded; sides nearly parallel to near the middle, then obliquely attenuate to near the tips, which are conjointly rather narrowly rounded, the lateral margins strongly serrate posteriorly, and when viewed from the side, are feebly sinuate, and with a more distinct sinuation for the posterior femora; each elytron with a broad obsolete basal depression, and with a very broad, deeper depression behind the humerus, broadly flattened along lateral margin and extending forward to the humeral angle; surface coarsely, obsoletely and irregularly punctate, and the intervals more or less obsoletely rugose. Abdomen beneath moderately

convex, densely, finely and obsoletely reticulate, and nearly glabrous; last segment acutely rounded at apex, the area in front of the marginal groove acutely rounded, with a rather acute tooth at the tip. Elytra epipleura narrow. Metasternum sparsely and coarsely punctate, and broadly, rectangularly emarginate in front. Prosternum feebly arcuately emarginate in front, the surface glabrous, obsoletely reticulate, and not distinctly punctate; prosternal process nearly four times as wide as the coxal cavities, sides feebly rounded, and broadly truncate at apex.

Length, 2.2 mm.; width, 1.4 mm.

Type locality.—Cavinas (Beni River), Bolivia.

Type.—Cat. No. 26981, U. S. N. M.

Described from a unique male collected at the type locality during January, 1922.

PACHYSCHELUS AENEICOLLIS (Kirsch)

Brachys aeneicollis Kirsch, Berl. Ent. Zeit., vol. 17, 1873, pp. 360–361.

Two specimens of this species were collected at Huachi (Beni River), during September, 1921.

PACHYSCHELUS VIRIDULUS (Kirsch)

Brachys viridulus Kirsch, Berl. Ent. Zeit., vol. 17, 1873, p. 362.

This species is represented by a single example collected at Riberalta (Beni River), during January, 1922.

PACHYSCHELUS NIGRIVENTRIS, new species

Female.—More narrowly cuneiform than *cavinas*, considerably longer than wide, broadly rounded in front, strongly attenuate posteriorly, distinctly narrower behind than in front, and rather strongly shining; head, pronotum and scutellum fuscous, the head with a feeble aeneous tinge, and the pronotum narrowly, obsoletely margined with green; elytra bluish-black, with a feeble violaceous reflection; beneath piceous, and more shining than above.

Head feebly convex, deeply embedded in the prothorax, and broadly, longitudinally grooved from vertex to epistoma, the groove rather deep on the front, but becoming obsolete on the vertex; surface glabrous, densely and finely granulose, with a few coarse, irregularly placed punctures intermixed. Pronotum feebly convex, three times as wide as long at middle, much narrower in front than behind, and widest at base; sides strongly obliquely arcuate from base to anterior angles, which are acutely angulated; anterior margin broadly and deeply arcuately emarginate; base transversely sinuate, acutely emarginate at elytral lobes, and nearly truncate in front of scutellum; posterior angles acute, projecting slightly beyond the humeral angles of elytra and fitting closely to them; surface sparsely clothed

with very short inconspicuous hairs, nearly smooth on the disk, but becoming finely and densely granulose, with a few coarse, shallow punctures intermixed toward the sides. Scutellum wider than long, glabrous, nearly smooth, with the anterior angles rectangular. Elytra about as wide as pronotum at base; humeral angles broadly rounded; sides parallel to near middle, then strongly obliquely attenuate to near the tips, which are conjointly rather narrowly rounded, the lateral margins strongly serrate posteriorly, and when viewed from the sides are feebly arcuate, with a feeble sinuation for the posterior femora; each elytron with a broad, obsolete basal depression, and with a broad, deeper one behind the humerus, broadly flattened along the lateral margin, and extending forward to the humeral angle; surface rather densely, coarsely and obsoletely punctate, the punctures arranged in rows and from each puncture arises a very short, recumbent, inconspicuous hair; intervals obsoletely rugose. Abdomen beneath moderately convex, densely, finely and obsoletely reticulate, and nearly glabrous; last segment strongly, narrowly produced, and armed at apex with eight, moderately long, sharp teeth, which are arcuately arranged, equally separated, and the median ones not more widely separated than the lateral ones, the ventral surface with a moderately deep, longitudinal depression, extending from the apex to near the middle, and a similar one on each side along the lateral margins. Elytral epipleura narrow. Metasternum sparsely, coarsely punctate, and feebly, broadly, rectangularly emarginate in front. Prosternum feebly arcuately emarginate in front, the surface nearly glabrous, smooth, and obsoletely reticulate; prosternal process nearly four times as wide as the coxal cavities, sides feebly rounded, and broadly truncate at apex.

Length, 2.5 mm.; width, 1.6 mm.

Type locality.—Cavinas (Beni River), Bolivia.

Type.—Cat. No. 26982, U.S.N.M.

Described from a unique female collected at the type locality during January, 1922.

PACHYSCHELUS BENIENSIS, new species

Male.—Ovate, distinctly longer than wide, broadly rounded in front, more attenuate posteriorly, slightly narrower behind than in front, and the surface nearly glabrous and moderately shining; above bluish-black, with a more or less purplish tinge, the head and sides of pronotum with an aeneo-viridis reflection, and the sides of elytra more violaceous; beneath piceous.

Head feebly and evenly convex, deeply embedded in the prothorax, and without a distinct longitudinal groove or any depressions on the front; surface glabrous, densely and finely granulose, with a few coarse, irregularly placed punctures intermixed. Pro-

notum moderately convex, three times as wide as long at middle, much narrower in front than behind, and widest at base; sides strongly obliquely arcuate from base to anterior angles, which are acutely angulated; anterior margin broadly and deeply arcuately emarginate; base transversely sinuate, acutely emarginate at elytral lobes, and broadly obsoletely emarginate in front of scutellum; posterior angles acute, not projecting, but fitting closely to the elytron; surface glabrous, densely, obsoletely granulose, with a few coarse, obsolete and irregularly placed punctures intermixed. Scutellum wider than long, glabrous, obsoletely granulose, with the anterior angles rectangular. Elytra slightly wider than pronotum at base, and widest at basal fourth; humeral angles broadly rounded; sides feebly arcuately rounded to near middle, then strongly arcuately attenuate to the tips, which are conjointly broadly rounded, the lateral margins rather strongly serrate posteriorly, and when viewed from the side are nearly straight, with a feeble sinuation for the posterior femora; each elytron with an indistinct basal depression, but with a broad, deep one behind the humerus, broadly flattened along lateral margin, and extending forward to the humeral angle; surface sparsely, obsoletely and irregularly punctate, the punctures not arranged in rows, coarser on basal region, but becoming obsolete posteriorly, clothed with a few very short inconspicuous hairs, and the intervals more or less obscurely rugose. Abdomen beneath moderately convex, finely, sparsely and obsoletely punctate, and clothed with a few very short, inconspicuous hairs; intervals finely and obsoletely reticulate; last segment acutely rounded at apex, the portion in front of the marginal groove acutely rounded, with a rather acute tooth at the tip. Elytral epipleura narrow. Metasternum sparsely, deeply and very coarsely punctate, and broadly, rather deeply arcuately emarginate in front. Prosternum feebly arcuately emarginate in front, the surface glabrous, smooth, and not distinctly punctate; prosternal process three times as wide as the coxal cavities, sides nearly parallel, and broadly rounded at apex.

Length, 2.25 mm.; width, 1.5 mm.

Type locality.—Huachi (Beni River), Bolivia.

Type.—Cat. No. 26983, U.S.N.M.

Described from a unique male collected at the type locality during September, 1921.

PACHYSCHELUS MODICUS Kerremans

Pachyschelus modicus KERREMANS, Ann. Soc. Ent. Belg., vol. 43, 1899, p. 355.

This species is represented by two examples, one collected near the mouth of the Mapiri River during September, 1921, and the other at Huachi (Beni River) during the same month.

BRACHYS TAKANA, new species

Female.—Broadly oblong, two times as long as wide, broadly rounded in front, and more acuminate behind, moderately shining and sparsely pubescent, the pubescence forming two more or less distinct fasciae on the elytra; head, pronotum, scutellum and body beneath piceous, with a feebly aeneous tinge; elytra black, with a strong purplish and bluish tinge.

Head feebly convex, not depressed behind epistoma and without gibbosities on the vertex, broadly and rather deeply longitudinally grooved on the front, the groove becoming obsolete on the occiput and at epistoma; surface finely, densely reticulate, with a few fine scattered punctures, and very sparsely clothed with rather long recumbent cinereous hairs, except for two glabrous spaces on the front; epistoma narrow between the antennal cavities, elevated, and not transversely carinate in front. Pronotum moderately convex, two and one-half times as wide as long at middle, distinctly narrower in front than behind, and widest at the base; sides obliquely attenunate from base to anterior angles (when viewed laterally the margin is feebly sinuate and more arcuate near the posterior angles for the reception of the anterior legs); anterior margin truncate; base transversely truncate to middle of each elytron, where it is feebly arcuately emarginate, then turning obliquely backward to the scutellum, in front of which it is feebly arcuately emarginate; posterior angles nearly rectangular; surface broadly depressed at the sides, the depression extending obliquely from the anterior angles to the base at middle of elytron, then transversely along base (but not as deeply depressed in front of scutellum), causing the antero-median part of the disk to be feebly, regularly convex, there is also an oblong elevation, with a more or less distinct carina on each side near the posterior angles; surface also densely, obsoletely reticulate, and sparsely, irregularly punctate, the punctures fine and deep on the convex area, but becoming ocellate-punctate in the depressed areas, and from each puncture arises a moderately long, recumbent, cinereous hair. Scutellum triangular, slightly wider than long, with the anterior margin feebly arcuately rounded, and the surface densely, obsoletely reticulate. Elytra slightly narrower than pronotum at base; humeral angles obtusely rounded; sides nearly parallel to middle (feebly arcuately emarginate at basal fourth), then obliquely attenuate (and obsoletely sinuate) to near the tips, which are conjointly broadly rounded, with the lateral margins entire; humeri prominent. Each elytron with a deep, broad, transverse depression at base, a narrower one between humerus and lateral margin, and with a distinct lateral carina, which is sinuate, strongly elevated, and extending from the humeral angle to near the apex, with a single

row of cinereous hairs extending from basal lobe to near middle, and with two more or less distinct transverse fasciae composed of sparsely placed, long, recumbent cinereous hairs arranged as follows: a broad irregular one at middle, and a similar one covering the apical fourth, there are also a few scattered hairs of the same color on the basal third, and between the median and apical fasciae the surface is sparsely clothed with inconspicuous semi-erect black hairs; surface finely and very irregularly punctate, and the intervals obsoletely reticulate and shining. Abdomen beneath very sparsely, ocellate-punctate, the punctures large, indistinct, open posteriorly, and from each puncture arises a short, recumbent cinereous hair; intervals finely and densely reticulate; last segment broadly obtusely rounded at apex, the margin armed with a series of regularly placed, narrow, parallel teeth, and the apical groove deep and following the outline of the posterior margin.

Length, 3 mm.; width, 1.45 mm.

Type locality.—Huachi (Beni River), Bolivia.

Type.—Cat. No. 26984, U.S.N.M.

Described from a single female collected at the type locality during September, 1921.

BRACHYS MOSITANA, new species

Male.—Broadly oblong, two times as long as wide, broadly rounded in front, and more acuminate behind, moderately shining and sparsely pubescent, the pubescence forming three more or less distinct fasciae on the elytra; head, pronotum, and scutellum piceous, with strong aeneo-cupreous tinge; elytra cyaneous, with the more densely pubescent areas feebly greenish; beneath piceous, with a feeble aeneous reflection.

Head feebly convex, broadly but feebly depressed behind the epistoma, and without gibbosities on the vertex, broadly and rather deeply longitudinally grooved from epistoma to the anterior part of occiput, the groove becoming broader and more obsolete toward epistoma; surface finely, obsoletely reticulate, with a few fine punctures on the occiput and near epistoma, the punctures very sparsely and irregularly spaced on the occiput, but becoming denser and more regular at the epistoma, and from each puncture arises a rather long semi-erect pale yellow hair, those on the occiput finer and more recumbent; epistoma very narrow between the antennal cavities, elevated, and not transversely carinate in front. Pronotum moderately convex, two and one-half times as wide as long, slightly narrower in front than behind, and widest at base; sides feebly arcuately attenuate from base to anterior angles (when viewed laterally the margin is abruptly arcuate near the posterior angles for the reception of the anterior legs); anterior margin truncate; base trans-

versely truncate to middle of each elytron, where it is feebly arcuately emarginate, then turning obliquely backward to the scutellum, in front of which it is feebly arcuately emarginate; posterior angles rectangular; surface strongly, broadly depressed at the sides, the depression extending obliquely from the anterior angles to the base at middle of elytron, then transversely along the base (but not quite as deeply depressed in front of scutellum), causing the anteromedian part of the disk to be strongly, regularly convex, with scarcely any elevation near the posterior angles, surface also densely, obsoletely reticulate, and sparsely, irregularly punctate, the punctures fine and deep on the convex area, but becoming ocellate-punctate in the depressed areas, and from each puncture arises a moderately long, recumbent, cinereous or fulvous hair. Scutellum triangular, slightly wider than long, with the anterior margin feebly arcuately rounded, and the surface densely, obsoletely reticulate. Elytra slightly wider than pronotum at base; humeral angles obtusely angulated; sides nearly parallel to just behind the middle (strongly arcuately emarginate to basal fourth), then obliquely attenuate to near the tips, which are conjointly broadly rounded; with the lateral margins entire; humeri very prominent. Each elytron with a broad, moderately deep, transverse depression at base, a broad elongate one between the humerus and lateral margin, and with a distinct lateral carina, which is sinuate, very strongly elevated, and extending from the humeral angle to near the apex, with a single row of closely placed cinereous hairs extending from basal lobe to near the middle of elytron, and with three more or less distinct transverse fasciae, composed of sparsely placed, semierect cinereous hairs arranged as follows: a broad, irregular, indistinct one at base, a narrower, more regular one at middle, and a broad one covering the apical fourth, and between these fasciae the surface is sparsely clothed with inconspicuous semierect black hairs; surface finely and very irregularly punctate, the punctures somewhat stelliform, and the intervals obsoletely reticulate and shining. Abdomen beneath sparsely, ocellate-punctate, the punctures large, shallow, open posteriorly, and from each puncture arises a rather short recumbent cinereous hair; intervals finely and densely reticulate; last segment broadly rounded at apex, with the margin entire, and the apical groove deep and following the outline of the posterior margin.

Length, 3 mm.; width, 1.4 mm.

Type locality.—Rio Colorado, Bolivia.

Type.—Cat. No. 26985, U.S.N.M.

Described from a unique male collected at the type locality during September, 1921. This species is named after one of the Indian tribes.

TAPHROCERUS PARVUS, new species

Elongate, broadly rounded in front, more strongly attenuate posteriorly, subcylindrical and moderately shining; above uniformly dark brown, with a strong aeneo-cupreous tinge, and clothed with a few short cinereous hairs, which form more or less obsolete spots on the apical half of the elytra; beneath piceous.

Head much narrower than pronotum at base, feebly convex, and narrowly flattened behind the epistoma, causing two round feeble gibbosities on the front, with a broad longitudinal groove extending from the occiput to epistoma, the groove obsolete on the occiput, deeply impressed on the front and more broadly expanded at the epistoma; surface finely, densely granulose, with a few obsolete punctures intermixed, and clothed with a few scattered cinereous hairs along the eyes. Pronotum moderately convex, two times as wide as long, slightly narrower in front than behind, widest at basal third; sides when viewed from above feebly arcuately rounded from base to apical third, then obliquely attenuate to the anterior angles: posterior angles nearly rectangular; anterior margin truncate; base transversely truncate to middle of elytron, then turning obliquely backward to the scutellum, in front of which it is narrowly, arcuately emarginate; surface with a narrow transverse depression along anterior margin, a broad one on each side along lateral margins, extending obliquely from the anterior angles to scutellum, in front of which it is broadly, but not deeply concave, these depressions causing the antero-median part to be regularly convex, and with a round elevation on each side near the posterior angles, finely, densely, and obsoletely granulose, with a few indistinct ocellate punctures intermixed, and sparsely clothed with cinereous hairs similar to those on head. Scutellum small, triangular, obsoletely granulose, and rounded in front. Elytra rather strongly convex, and as wide as pronotum at base; humeral angles obtusely angulated; sides parallel to middle (strongly arcuately constricted at basal third), then strongly obliquely attenuate to the tips, which are separately narrowly rounded, and obsoletely serrate; humeri moderately developed; each elytron with a deep, rather broad, transverse basal depression, and with a more or less obsolete lateral carina extending from humerus to apex, the carina strongly sinuate and following the outline of the lateral margin; surface with rows of coarse very shallow, obsolete punctures, the punctures more distinct on basal area, but becoming obsolete posteriorly, the intervals obsoletely granulose. Abdomen beneath sparsely and obsoletely punctate, the punctures very shallow, obsoletely impressed, oblong, and open on the one side, and clothed with a few short obsolete hairs; intervals finely and densely reticulate; last segment broadly rounded at apex, with the apical groove deep

and following the outline of the margin. Metasternum more coarsely and distinctly punctured than the abdomen. Prosternum coarsely and densely granulose.

Length, 2.75 mm.; width, 1 mm.

Type locality.—Tumupasa, Bolivia.

Type.—Cat. No. 26986, U.S.N.M.

Described from a single specimen collected at the type locality during December, 1921.

LEIOPLEURA GORAI, new species

Female.—Oblong, moderately convex, broadly rounded in front, more arcuately attenuate posteriorly, nearly as wide behind as in front, and strongly shining; uniformly black above and beneath, with the front of head green, and the sides of the pronotum feebly narrowly aeneous.

Head moderately, evenly convex, with an obsolete depression on the front and a similar one on the vertex, and with a narrow longitudinal groove extending between the two depressions, but becoming obsolete on occiput and near the epistoma; surface glabrous, rather finely, very sparsely, and obsoletely punctate, the intervals smooth posteriorly, but becoming finely and densely granulose toward the epistoma; antennae short, piceous, with a feebly aeneous tinge. Pronotum moderately convex, two times as wide as long, distinctly narrower in front than behind, and widest at base; sides strongly arcuately attenuate from base to anterior angles; posterior angles feebly projecting and rather acute; anterior margin rather strongly arcuately emarginate; base transversely truncate to middle of elytron, where it is feebly emarginate, then turning obliquely backward to the scutellum, in front of which it is truncate; surface broadly flattened along the sides, the depression extending obliquely from the anterior angles to base at middle of elytron, then transversely along base, where it is broadly concave in front of scutellum, and more deeply triangularly depressed on each side near the posterior angles, causing the antero-median part to be regularly convex, and with the lateral carina only feebly indicated, finely, sparsely and irregularly punctate, the punctures indistinct, and the intervals finely and obsoletely reticulate. Scutellum triangular, sides about equal in length, and the surface nearly smooth. Elytra moderately convex, as wide as pronotum at base, and widest at middle; humeral angles broadly rounded; sides feebly arcuately expanded to near middle, then strongly arcuately attenuate to the tips, which are conjointly broadly rounded, with the lateral margins finely serrate posteriorly; humeri strongly developed; each elytron with a broad, very deep, transverse depression at base, a narrow, deep one between the humerus and lateral

margin, extending along the margin from humeral angle to middle, and broadly expanded behind the humerus; surface glabrous, finely, sparsely and irregularly punctate, with the intervals smooth. Abdomen beneath finely and densely reticulate-striolate, with a few fine obsolete punctures intermixed, and sparsely clothed with very short inconspicuous hairs; first segment coarsely, longitudinally striate at base. Prosternum glabrous, and smooth along anterior margin; prosternal process broad, the surface densely and very coarsely punctate. Metasturnum obsoletely reticulate, with a few indistinct punctures and longitudinal striae intermixed; anterior margin feebly arcuately emarginate.

Length, 2.7 mm.; width, 1.4 mm.

Type locality.—Reyes, Bolivia.

Type.—Cat. No. 26991, U.S.N.M.

Described from a unique female collected at the type locality during October, 1921.

LEIOPLEURA BOLIVIANA, new species

Male.—Broadly oblong, rather strongly convex, about equally rounded in front and behind, and strongly shining; head, pronotum and elytra bright green, with the posterior margin of head, a narrow oblong spot on disk of the pronotum, and scutellum fuscous, the elytra more or less blackish-cyaneous on humeri and along the lateral margins; beneath black.

Head moderately, evenly convex, not depressed on the front, but with a very narrow longitudinal groove extending from the occiput to a deep round pit behind the epistoma, the groove obsolete on the occiput, but more distinct on the front; surface glabrous, sparsely, coarsely and irregularly punctate, and the intervals smooth on the vertex and occiput, but becoming finely and densely granulose toward the epistoma; antennae short and entirely piceous. Pronotum moderately, evenly convex, two and one-half times as wide as long, much narrower in front than behind, and widest at base; sides feebly arcuate near base, then strongly obliquely attenuate to the anterior angles; posterior angles feebly projecting and rather acute; anterior margin broadly arcuately emarginate; base nearly transversely truncate to middle of elytron, where it is feebly emarginate, then turning obliquely backward to the scutellum, in front of which it is truncate; surface strongly declivous toward the anterior angles, with a broad obsolete depression on each side at base near middle of elytron, and without a lateral carina, coarsely, rather densely and irregularly punctate, the intervals nearly smooth on the disk, but becoming densely and rather coarsely reticulate toward the sides. Scutellum triangular, sides about equal in length,

and the surface nearly smooth. Elytra moderately convex, wider than pronotum at base, and widest just behind the middle; humeral angles broadly rounded; sides feebly expanded from base to just behind the middle, then strongly arcuately attenuate to the tips, which are conjointly, rather narrowly rounded, with the lateral margins finely serrate to humeral angles; humeri strongly developed; each elytron with a broad, deep depression at base, and a narrow deeper one between the humerus and lateral margin, extending along the margin from the humeral angle to middle, and broadly expanded behind the humerus; surface glabrous, rather densely, coarsely and irregularly punctate, the intervals obsoletely rugose toward the sides. Abdomen beneath finely and densely reticulate-striolate, with a few obsolete punctures intermixed, and without distinct pubescence. Prosternum smooth and transversely sulcate along anterior margin; prosternal process finely and sparsely punctate, and sparsely clothed with moderately long recumbent brownish hairs. Metasternum very coarsely and densely punctate, the punctures shallow, oblong, and more or less confluent; anterior margin deeply arcuately emarginate.

Female.—Differs from the male in having the front of head fuscous, and the prosternal process smooth and not pubescent.

Length, 3.25 mm.; width, 2 mm.

Type locality.—Canamina, Bolivia.

Type, allotype and paratypes.—Cat. No. 26992, U.S.N.M.

This species is described from a fairly large series of specimens collected at the type locality during July, 1921.

CALLIMICRA ACUMINATA, new species

Male.—Oblong, moderately convex, broadly rounded in front, strongly attenuate posteriorly, distinctly narrower behind than in front, and moderately shining; head brilliant green, and feebly cuperous on occiput; pronotum green, becoming more or less cupreous and fuscous on disk; scutellum brownish-cupreous; elytra black; beneath piceous.

Head moderately convex, with a broad, shallow longitudinal groove, extending from the occiput to middle of front, where it terminates in a round shallow depression; surface densely, coarsely granulose, with numerous large obsolete punctures intermixed; antennae slightly aeneo-viridis. Pronotum moderately convex, two times as wide as long, distinctly narrower in front than behind, and widest along basal third; sides feebly arcuate from base to near middle, then more arcuately attenuate to the anterior angles; posterior angles rather acute; anterior margin feebly arcuately emarginate; base transversely sinuate to middle of elytron, then turning

obliquely backward to the scutellum, in front of which it is truncate; surface narrowly depressed along sides, and with a broad, deep, transverse depression along base, extending nearly to the posterior angles, and without a distinct lateral carina, finely, sparsely and irregularly punctate, the intervals smooth on the disk, but finely, densely granulose along the lateral margins. Scutellum smooth and triangular. Elytra moderately convex, about as wide as pronotum at base; humeral angles obtusely rounded; sides nearly parallel to middle, then obliquely attenuate to the tips, which are conjointly rather broadly rounded, with the lateral margins densely finely serrate posteriorly; humeri rather strongly developed; each elytron with a narrow, moderately deep, transverse basal depression, and with a narrow deep depression between the humerus and lateral margin; surface sparsely and irregularly punctate, the punctures very irregular in size and nearly obsolete toward the apex, with the intervals smooth. Abdomen beneath densely and finely reticulate, with a few fine obsolete punctures intermixed, and sparsely clothed with very short inconspicuous hairs; last segment broadly rounded at apex. Prosternum glabrous, smooth anteriorly, with a few coarse, deep, closely placed punctures on the prosternal process, which is rather short, broad, sides arcuate, and the apex broadly rounded; anterior margin feebly arcuately rounded. Metasternum feebly arcuately emarginate in front.

Length, 3.25 mm.; width, 1.4 mm.

Type locality.—Huachi (Beni River), Bolivia.

Type.—Cat. No. 26987, U.S.N.M.

Described from a unique male collected at the type locality during September, 1921.

CALLIMICRA FESTIVA, new species

Female.—Oblong, moderately convex, rather broadly rounded in front and behind, not distinctly narrower behind than in front, and strongly shining; above bluish-green, with the pronotum and posterior part of head slightly cupreous and aureous, the former with a distinct violaceous tinge at base; beneath piceous.

Head moderately convex, the front with a broad, rather deep longitudinal groove; vertex and occiput narrowly longitudinally carinate; surface sparsely, coarsely, and irregularly punctate, the intervals nearly smooth posteriorly, but becoming finely reticulate toward the epistoma; antennae black, with a feeble aeneous tinge. Pronotum moderately convex, two and one-fourth times as wide as long, distinctly narrower in front than behind, widest along basal third; sides feebly arcuate from base to near middle, then strongly arcuately attenuate to the anterior angles; posterior angles obtusely

angulated; anterior margin rather strongly arcuately emarginate, with a broadly rounded obsolete median lobe; base transversely feebly sinuate to middle of elytron, then turning obliquely backward to the scutellum, in front of which it is broadly subtruncate; surface broadly depressed along sides, and with a broad, transverse concave depression along base, extending to exterior third, where the depression is deeper and more triangular, and with an obsolete lateral carina, extending from base to middle of pronotum, finely, sparsely, and irregularly punctate, the punctures becoming coarser toward the sides, the intervals smooth on the disk, but becoming finely, densely reticulate along the lateral margins. Scutellum triangular, and obsoletely reticulate. Elytra moderately convex, about as wide as pronotum at base; humeral angles obtusely angulated; sides nearly parallel to apical third (feebly arcuately constricted at middle), then arcuately attenuate to the tips, which are separately narrowly rounded, with the lateral margins finely and densely serrate posteriorly; humeri rather strongly developed; each elytron with a narrow, moderately deep transverse depression along base, and a broad shallow one behind the humerus, and narrowly extended along lateral margin to humeral angle; surface finely, sparsely, and irregularly punctate, with the intervals smooth on the disk, but becoming transversely uneven behind the humerus. Abdomen beneath finely and densely reticulate, with a few fine obsolete punctures intermixed, and sparsely clothed with very short, inconspicuous hairs; last segment broadly subtruncate at apex. Prosternum glabrous, and coarsely sparsely, and irregularly punctate; prosternal process long, broad, sides arcuate, and the apex broadly rounded; anterior margin broadly arcuately rounded. Metasternum deeply arcuately emarginate in front.

Length 5 mm.; width, 2.25 mm.

Type locality.—Canamina, Bolivia.

Type.—Cat. No. 26988, U.S.N.M.

Described from a unique female collected at the type locally during July, 1921.

CALLIMICRA CYANOPTERA, new species

Male.—Oblong, moderately convex, about equally broadly rounded behind and in front, and rather strongly shining; head and pronotum bright green, with a distinct aureous tinge, the latter more or less fuscous on the disk; scutellum piceous; elytra cyaneous, with a strong violaceous tinge; beneath piceous.

Head moderately convex, broadly, obsoletely longitudinally depressed from vertex to epistoma, with a round deep depression on the front; occiput with a narrow longitudinal carina; surface coarsely, densely granulose, with numerous large obsolete punctures

intermixed; antennae feebly aeneous. Pronotum moderately convex, not quite two times as wide as long, narrower in front than behind, widest along basal half; sides feebly arcuate from base to middle, then more arcuately attenuate to the anterior angles; posterior angles obtusely angulated; anterior margin feebly arcuately emarginate, with a broadly rounded obsolete median lobe; base transversely truncate to middle of elytron, then with a broadly arcuately rounded median lobe; surface rather broadly depressed along sides, with a deep, broadly concave, transverse depression along base, extending to the posterior angles, and becoming deeper and more triangular at the sides, and with a short lateral carina, which does not extend to the base, sparsely, rather coarsely, and irregularly punctate, and the intervals densely and finely reticulate. Scutellum triangular, and obsoletely reticulate. Elytra moderatly convex, slightly narrower than pronotum at base; humeral angles obtusely angulated; sides nearly parallel to just behind the middle (feebly arcuately constricted at middle), then arcuately attenuate to the tips, which are separately narrowly rounded, with the lateral margins obsoletely serrate posteriorly; humeri rather strongly developed; each elytron with a rather broad, deep, transverse basal depression, and a similar one along lateral margin, extending from humeral angle to middle, and becoming broader posteriorly; surface finely, sparsely and irregularly punctate, the punctures tending to form rows on the disk, with the intervals smooth posteriorly, but becoming more or less rugose on the basal region. Abdomen beneath densely, obsoletely reticulate, with a few obsolete punctures intermixed, and sparsely clothed with very short inconspicuous hairs; last segment rather narrowly rounded at apex. Prosternum clothed with a few long erect hairs, subopaque, and finely and very densely granulose; prosternal process long, broad, sides parallel, and the apex broadly rounded; anterior margin broadly arcuately rounded. Metasternum deeply arcuately emarginate in front.

Female.—Differs from the male in being more robust, scutellum cupreous, lateral carinae on pronotum more distinct, last abdominal segment more broadly rounded at apex. and the prosternal process sparsely and coarsely punctate.

Length, 3.5 mm.; width, 1.3–1.5 mm.

Type locality.—Huachi (Beni River), Bolivia.

Other localities.—Rurrenabaque (Beni River), Bolivia.

Type, allotype and paratypes.—Cat. No. 26990, U.S.N.M.

Described from six specimens, two males and four females. The type, allotype and one female paratype collected at Huachi during September, 1921, and one male and two female paratypes collected at Rurrenabaque during October and November, 1921.

CALLIMICRA VIRIDIFRONS, new species

Female.—Oblong, moderately convex, about equally broadly rounded in front and behind, and strongly shining; head and pronotum bright green, with a distinct aureous tinge, the latter more or less bluish-green on the disk; scutellum aureo-cupreous; elytra green, with a violaceous tinge along the sides; beneath piceous, with a more or less distinct aeneous tinge.

Head rather strongly convex, not distinctly longitudinally sulcate, but with a rather deep triangular depression on the front; occiput feebly longitudinally carinate; surface rather densely, coarsely and irregularly punctate, the intervals smooth posteriorly, but becoming densely and finely granulose toward the epistoma; antennae feebly cupreous. Pronotum rather strongly convex, two times as wide as long, slightly narrower in front than behind, widest along basal half; sides feebly arcuate from base to middle, then more arcuately attenuate to the anterior angles; posterior angles obtusely angulated; anterior margin deeply arcuately emarginate, with a broadly rounded obsolete median lobe; base transversely truncate to middle of elytron, then turning obliquely backward to the scutellum, in front of which it is broadly subtruncate; surface rather broadly depressed along sides, with a deep, broadly concave transverse depression along base, extending to the posterior angles, and becoming deeper and more triangular toward the sides, and with a distinctly elevated arcuate lateral carina, which extends from base to middle of pronotum, finely, sparsely and irregularly punctate, the punctures obsolete on the disk, but becoming coarser toward the sides, the intervals nearly smooth on the disk, but finely, densely reticulate along the lateral margins. Scutellum triangular, and obsoletely reticulate. Elytra moderately convex, about as wide as pronotum at base, humeral angles obtusely angulated; sides parallel to apical third (obsoletely arcuately constricted at middle), then broadly arcuately attenuate to the tips, which are conjointly broadly rounded, with the lateral margins finely and densely serrate posteriorly; humeri strongly developed; each elytron with a rather broad, deep transverse basal depression, and a similar one along lateral margin, extending from humeral angle to near the middle, and becoming broader behind the humerus; surface finely and rather densely punctate, the punctures more or less stelliform and very irregularly placed, with the intervals obsoletely rugose. Abdomen beneath densely and finely reticulate, with numerous fine, obsolete punctures intermixed, and sparsely clothed with very short inconspicuous hairs; last segment broadly rounded at apex. Prosternum clothed with a few rather long erect hairs, and sparsely, coarsely punctate; prosternal process long, broad, sides parallel, and the apex broadly

rounded; anterior margin broadly, arcuately rounded. Metasternum deeply, angularly emarginate in front.

Length, 3.5 mm.; width, 1.6 mm.

Type locality.—Huachi (Beni River), Bolivia.

Type and paratypes.—Cat. No. 26989, U.S.N.M.

Described from three specimens, probably females, collected at the type locality during September, 1921.

O

HARPIDIUM, A NEW PENTAMEROID BRACHIOPOD GENUS FROM SOUTHEASTERN ALASKA.

By Edwin Kirk

Of the United States Geological Survey

In an earlier paper[1] I described the new genus *Brooksina* from a series of sediments in southeastern Alaska tentatively referred to the upper Silurian. In that paper will be found a brief discussion of the faunal affinities of the series. A more detailed study of the *Brooksina* fauna together with the faunas of lower and higher horizons strengthens the belief that the formations in question should be assigned to the upper Silurian rather than to the lower Devonian. There are certain elements suggestive of the Devonian, but there is little to compel a correlation with the widespread and characteristic lower Devonian or Helderbergian faunas. On the other hand, our scant knowledge of latest Silurian normal marine sediments with their contained faunas leaves a faunal gap into which these Alaskan faunas may well fit. Within this time interval should be placed, I think, those faunas of the Ural Mountains commonly referred to the lower Devonian.

In the limestone series characterized by *Brooksina alaskensis* is another pentameroid of considerable interest. To this genus the name *Harpidium* is here given. The genus is not represented elsewhere than in this restricted zone of the upper Silurian of Southeastern Alaska, so far as known. *Conchidium* (?) *occidentalis* Hall from the Guelph dolomites of Ontario resembles *Harpidium* in general form. Detailed knowledge of the structure of the species is wanting. *C.* (?) *occidentalis* has, however, obscure radial plications that are wanting in the Alaskan species of *Harpidium*. Even so its affinities may prove to be closer to *Harpidium* than to *Conchidium*, to which it was doubtfully referred by Hall and Clarke.

GENERIC DIAGNOSIS

Harpidium may briefly be defined as a nonplicated pentameroid of large size with highly arched valves. The pedicle valve has a

[1] Kirk, E., Brooksina, a new pentameroid genus from the upper Silurian of southeastern Alaska: Proc. U. S. Nat. Mus., vol. 60, art. 19, pp. 1–8, pl. 1, 1922.

high strongly incurved beak and is also characterized by long, well-defined cardinal slopes. Well-developed, elevated, convex deltidial plates are present. The brachial valve is also strongly incurved in the apical portion. The valves are either smoothly convex (possibly only in immature individuals) or have well-defined median sinuses. The shell is much thicker than in most pentameroids and is fibrous. The septum of the pedicle valve is relatively very short and supports a spondylium of great length. The septa of the brachial valve are discrete, subparallel in relation to one another, and support crural plates similar to those of *Conchidium.*

Genotype.—Harpidium insignis, new species, has been chosen as the type of the genus.

Harpdium resembles *Conchidium* in the general proportions and contours of its valves. The median sinus in each valve is also a character that occasionally is to be found in *Conchidium.* It differs from *Conchidium*, however, in its nonplicated shell and in the shortness of the septum in the pedicle valve. The heavy, convex, elevated deltidial plates are also very different from the deltidial plates of *Conchidium.* The spondylium is of about the size and proportions to be found in *Conchidium.* The genus resembles *Pentamerus* in that the shell is nonplicated. There its resemblance ceases. The highly arched incurving apical portion of the valves, the long well marked cardinal slopes of the pedicle valve, the median sinuses of both valves, and the internal structures set the genus clearly apart from *Pentamerus. Harpidium* and *Conchidium* are, I believe, much closer genetically than either is to *Pentamerus.* In this connection it is of interest to note that as yet no true *Pentamerus* has been found in faunas of the north Pacific type. In the Porcupine River region of the interior of Alaska what appears to be a *Pentamerus* has been found. This interior region of Alaska, however, has as a rule closer affinities with the Rocky Mountain Geosyncline and the interior of North America than it has with the true Pacific region. The more or less complete separation of Pacific and interior faunas seems to have held up to the time of the high middle Devonian when there seems to have been fairly free communication between the two faunal regions.

HARPIDIUM INSIGNIS, new species

Plate 1, figs. 1–6; plate 2, fig. 7

This species reaches a fairly large size. The largest fairly perfect individual in the collections gives the following measurements: Length (pedicle valve), 7.5+ cm.; maximum breadth, 6.5 cm.; maximum depth, 7.5± cm. Fragmentary material indicates that the species attained a size perhaps half again as large. Smaller speci-

mens are relatively narrower and less deep, as indicated by the following measurements:

Length	4.0 cm.	5.6 cm.	5.4 cm.
Maximum breadth	3.2 cm.	4.4 cm.	4.7 cm.
Maximum depth	2.9± cm.	4.4 cm.	4.8 cm.

It is to be noted that the disproportion between the size of the valves becomes more marked with age, in the adult specimen the pedicle valve greatly exceeding the brachial valve in size.

The pedicle valve is narrow in its apical portion, highly arched, and with a strongly incurved beak. Anteriorly it remains highly arched, but gradually a flattened median area is developed that changes to a broad, well-defined sinus. The cardinal slopes are long and are as sharply defined as in *Conchidium*, other than as not being differentiated by being smooth as opposed to the plicated remainder of the shell. The delthyrium is large and bordered on either side by a well-developed heavy convex deltidial plat. When the deltidial plates are not present their former lines of attachment can be seen as narrow, sharply incised grooves at the margins of the delthyrium. The brachial valve is highly arched in the younger specimens, becoming relatively less so with increasing age. The apical portion is strongly incurved. As in the pedicle valve the brachial valve develops a broad median sinus. The surface of the shell is marked by fairly strong growth lines. The shell substance is fibrous, with the fibers running longitudinally. When partially exfoliated, under a magnifying glass the fine longitudinal fibrous structure can occasionally be seen.

The septum of the pedicle valve is very short, but deep. It is concave at the anterior wall. The spondylium, supported only in its posterior portion, is a great sickle or scimitar-shaped affair, in proportion to the septum, being much larger than in any other known pentameroid. The septa of the brachial valve lie subparallel or slightly divergent, are low, and support the normal crural structures for *Conchidium*.

Horizon and locality.—From the limestone of the *Brooksina* horizon on the north shore of Heceta Island and the south shore of Kosciusko Island, Southeastern Alaska.

Cotypes.—Cat. Nos. 70228, 70229, U.S.N.M.

HARPIDIUM ROTUNDUS, new species

Plate 2, fig. 8

At a somewhat higher horizon than the main horizon of *H. insignis* occurs another *Harpidium* that seems to be distinct and for which the name *Harpidium rotundus* is here proposed.

As known *H. rotundus* is a smaller species than *H. insignis*, the largest undoubted representative of the species giving the following

measurements: maximum length, 5.2 cm.; maximum breadth, 5.1 cm.; and maximum depth, 4 cm.

The pedicle valve is strongly incurved in its apical portion. Anteriorally the valve widens more rapidly than in *H. insignis*, attaining a maximum breadth approximately equal to the length. This relative proportion of length to breadth holds in moderately small as well as adult individuals. The cardinal slopes are well defined, but relatively smaller than in *H. insignis.* The pedicle valve is moderately and evenly arched. Although larger than the brachial valve there is not the striking disproportion in size between the valves that is characteristic of *H. insignis.* The brachial valve is strongly incurved in its apical portion. In neither valve as seen is a well defined median sinus developed, although there is a slight median flattening and a well marked flexure of the anterior margin of the valves.

The shell is thick and the surface is marked by fine concentric growth lines.

H. rotundus may readily be distinguished from *H. insignis* by its relatively greater breadth, the lack of sharply defined median sinuses in the valves (although this character is developed in a larger crushed specimen that is doubtfully referred to this species), and by the less highly arched and relatively smaller pedicle valve.

Horizon and locality.—The species is known only from the Brooksina-bearing limestone series on the north shore of Heceta Island, Southeastern Island.

Holotype.—Cat. No. 70230, U.S.N.M.

HARPIDIUM LATUS, new species

Plate 2, figs. 1–6

In the *Brooksina alaskensis* zone on Kosciusko Island, Southeastern Alaska, a small species of *Harpidium* is found in fairly large numbers.

This species, here named *Harpidium latus*, differs widely from the younger stages of both *H. insignis* and *H. rotundus.* On the other hand, being fairly common in a zone where hundreds of well preserved brachiopods were collected, it seems highly improbable that the specimens represent immature stages of still another species of large size. Measurements of a series of specimens are here given:

Length	2.7 cm.	2.4+ cm.	2.0 cm.	1.15 cm.	0.9 cm.
Maximum breadth	3.1 cm.	3.0 cm.	2.5 cm.	1.45 cm.	1.14 cm.
Maximum depth	2.1 cm.	1.75 cm.	1.3 cm.	.75 cm.	.6 cm.

The largest specimen seen, which has been badly weathered, has an approximate length of 3. cm., maximum breadth of more than 3. cm., and a maximum depth of about 2.5 cm.

The apical portion of the pedicle valve is incurved but not strongly so. The valve is moderately arched, and there is a suggestion of a median longitudinal flattening. The pedicle valve widens very rapidly, and the cardinal slopes are sharply defined. This gives a structure which so closely simulates the hinge and area of the simpler smooth spiriferoids that as a matter of fact it is often difficult to distinguish between a young *Harpidium latus* and an associated spiriferoid. The apical portion of the brachial valve is sharply incurved. The remainder of the valve is moderately arched. The pedicle valve exceeds the brachial valve in size but not to the extent found in either of the other species. The anterior margin of the shell is gently sinuate. The exterior of the shell is smooth or marked by fine concentric growth lines.

H. latus is readily distinguished from younger specimens of the other species described by its greater proportionate breadth, the nearly straight hinge-like union of the valves, the area-like cardinal slopes, and the less preponderance of the pedicle over the brachial valve.

Horizon and locality.—This species has only been found associated with *Brooksina alaskensis* in the south-central part of Kosciusko Island, Southeastern Alaska.

Cotypes.—Cat. No. 70231, U.S.N.M.

All the type specimens are in the collections of the United States National Museum and were collected by the writer.

EXPLANATION OF PLATES

Plate 1

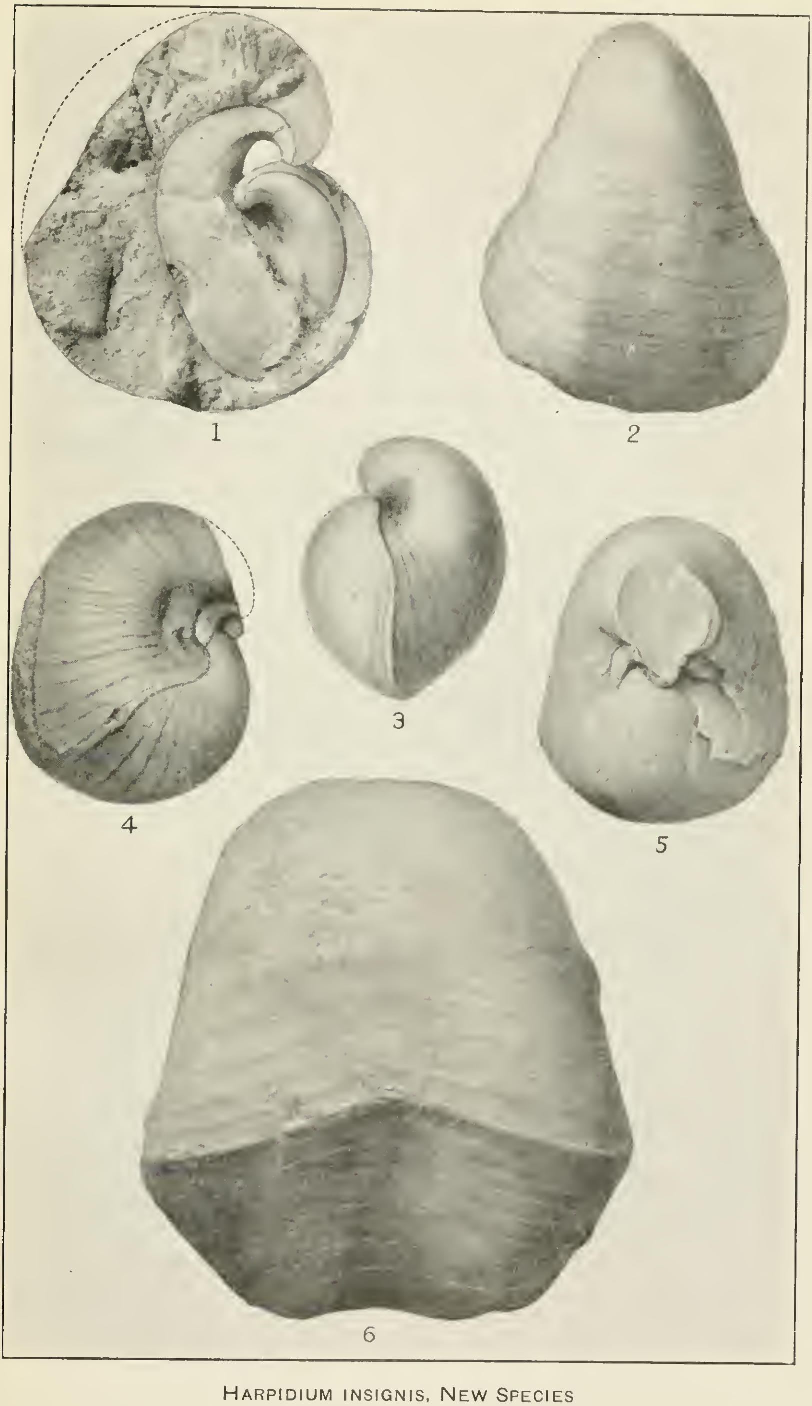
Harpidium insignis, new species

Fig. 1. Median section of an individual showing septa of the pedicle and brachial valves, and the relatively enormous spondylium.

2. Pedicle valve of a medium sized individual.
3. Side view of a small individual.

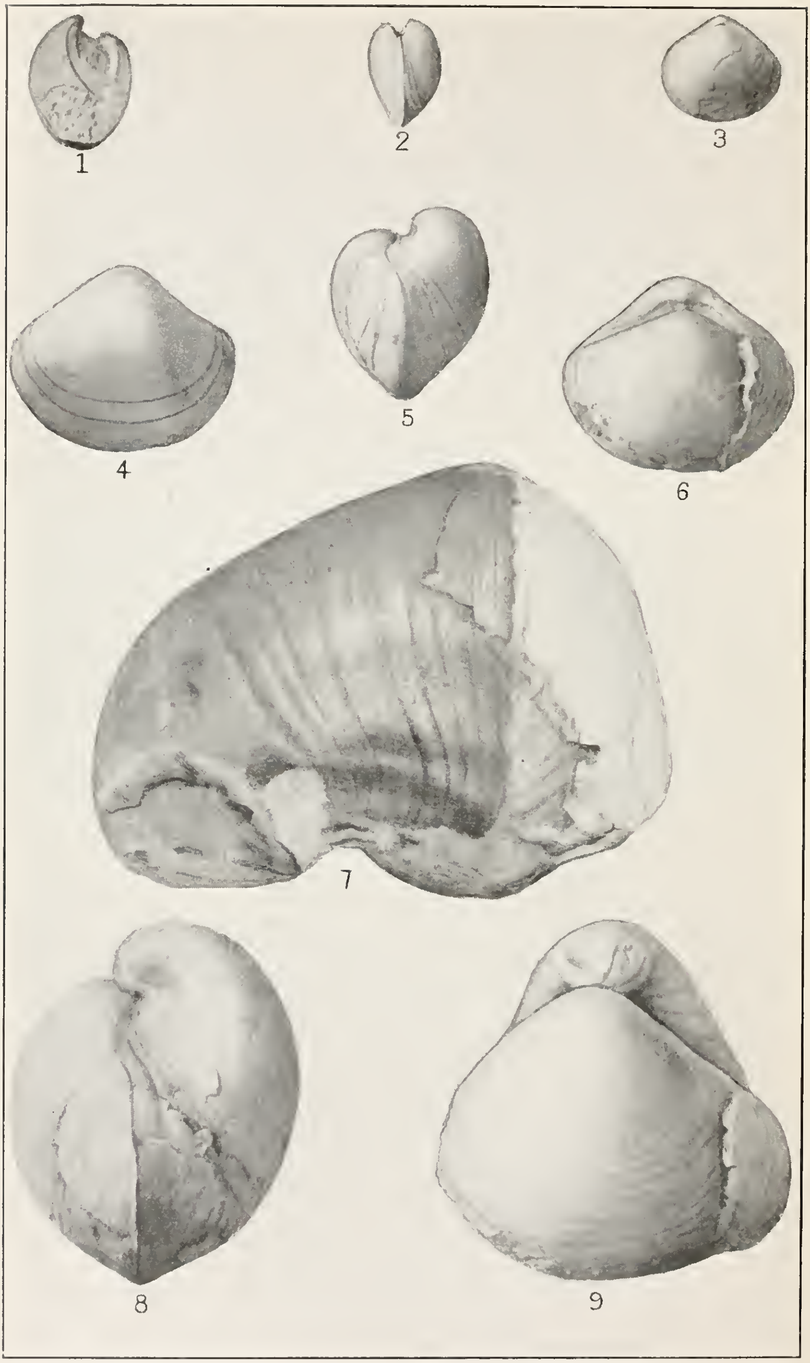
4,5. Side and cardinal views of a small individual showing the deltidial plates.

6. Anterior view of an adult individual of average size. The side view of this same specimen is shown in plate 2, figure 7.



HARPIDIUM INSIGNIS, NEW SPECIES

FOR EXPLANATION OF PLATE SEE PAGE



HARPIDIUM LATUS, H. INSIGNIS, AND H. ROTUNDUS

FOR EXPLANATION OF PLATE SEE PAGE 7

PLATE 2

Harpidium latus, new species

FIG. 1. Median section of medium-sized specimen showing septa of pedicle and brachial valves and spondylium.

2,3. Side and dorsal views of a medium-sized individual.

4,5,6. Ventral, side, and dorsal views of the largest well-preserved specimen found.

Harpidium insignis, new species

7. Side view of the same individual as in plate 1, figure 6, showing the great disproportion in size between the brachial and pedicle valves.

Harpidium rotundus, new species

8,9. Side and dorsal views of an adult individual.

7

O

NOTES ON THE FISHES OF HAWAII, WITH DESCRIPTIONS OF SIX NEW SPECIES

By Eric Knight Jordan

Of Stanford University, California

I

The present writer spent the month of August, 1924, at Honolulu, in company with his father, David Starr Jordan, in attendance at the Pan-Pacific Food Conservation Conference. All his available time was spent in collection and study at the fish markets. Of the large collections obtained, the first series was sent to Cornell University, the second to the University of Minnesota, and smaller series to Chicago University, to the Imperial University of Tokyo, and to Brigham Young University. The types of new species were placed in the United States National Museum, which institution publishes the present notes. The plates are the work of the late William S. Atkinson, artist in zoology and botany, at Stanford University.

The writer is indebted to his father for many suggestions, especially for aid in the determination of species. Prof. Frederick G. Krauss, of the University of Hawaii, has given him important assistance in connection with this work, and the Matson Navigation Company has shown the special courtesy of transporting the collections without charge to San Francisco.

In this paper I have included references to all species added to the Hawaiian fauna since the publication in 1922 of Jordan and Jordan's List of the Fishes of Hawaii.[1] The most important of these additions are recorded in Henry W. Fowler's New or Little Known Hawaiian Fishes.[2] References to the additional species secured by Mr. Fowler on his visit to Honolulu in the autumn of 1922, are made in the present paper. In the time at my disposal, I was able to examine or secure about 220 species, some fishes being too large for convenient preservation. Many of the coral reef fishes

[1] Memoirs of the Carnegie Museum, vol. 10, No. 1, Dec., 1922.
[2] Occasional Papers of the Bernice Pauahi Bishop Museum, vol. 8, No. 7, 1923.

could not be obtained in the time I could spare, and I have reason to believe that overfishing, and, more especially, the use of dynamite, not yet effectually prohibited, has reduced the number of shore fishes to less than one-fourth the abundance noted by Jordan and Evermann in 1901.[3]

To this last work the present paper, and the previous one of Jordan and Jordan, containing the complete list up to 1922, are supplementary.

In this paper the following genera and species are described as new:

Genera: *Leihala*, *Opua*.

Species: *Lepidaplois atrorubens*, *Scaridea farrandi*, *Scarus kraussi*, *Scarus galena*, *Opua nephodes*, *Cantherines verecundus*.

Family EULAMIIDAE

Genus EULAMIA Gill

EULAMIA MUNSING (Bleeker).

Mr. Fowler records this East Indian shark from Hononlulu.

Family ECHINORHINIDAE

Genus ECHINORHINUS Blainville

ECHINORHINUS BRUCUS (Bonnaterre).

Recorded by Fowler from Honolulu.

Family ISISTIIDAE

Genus ISISTIUS Gill

ISISTIUS, species.

Represented by a cast in the Bishop Museum. It is a very small shark with the two dorsals set far back, and very small, about the size of the ventrals which are opposite the interspace; no anal fin.

Family MOBULIDAE

Genus MANTA Bancroft

MANTA BIROSTRIS (Walbaum).

Recorded from Honolulu by Fowler.

Family DUSSUMIERIIDAE

Genus SPRATELLOIDES Bleeker

SPRATELLOIDES DELICATULUS (Bennett).

Recorded by Fowler from Honolulu as *Stolephorus delicatulus*, but the name *Stolephorus* is now regarded as properly assigned to a

[3] The Aquatic Resources of the Hawaiian Islands, Bull. U. S. Fish Commission for 1903. (Issued 1905.)

group of anchovies. As now understood by Jordan and Seale *Stolephorus* differs from the New World anchovies (*Anchoviella*, etc.), in the presence of ventral scutes, these beng absent in all the American species.

Family ENGRAULIDAE

Genus ANCHOVIELLA Fowler

ANCHOVIELLA PURPUREA (Fowler).

This little anchovy, or *Nehu*, is very abundant about Honolulu. It is used as bait, especially for the *Aku*, or Oceanic Bonito (*Katsuwonus pelamys*), the most abundant large fish now in the Honolulu markets. Its coarse red flesh is again used as bait for the various tunnies, spear-fish, and *Ono* (*Acanthocybium*).

Family CHANIDAE

Genus CHANOS Lacépède

The genus *Chanos* is wide spread along the shores of the Pacific from Lower California and Japan to the Red Sea and Australia. Of late it has been assumed that (excepting *Chanos lubina*, which has 19 dorsal rays) all the representatives of the genus belong to one species. This conclusion is at least doubtful, as our Hawaiian and Mexican examples have 86 scales in the lateral line, while the species of the Red Sea (*Mugil chanos* Forskål or *Chanos arabica* Cuvier and Valenciennes), has but 75. This form of the North Pacific may be provisionally regarded as a distinct species, *Chanos cyprinella*.

CHANOS CYPRINELLA Cuvier and Valenciennes.

This form was described from Honolulu ("Onoruru"), where it is a valued food fish, the flesh of an excellent flavor though with many small bones.

Family GONORHYNCHIDAE

Genus GONORHYCHUS (Gronow) Scopoli

GONORHYNCHUS MOSELEYI Jordan and Snyder.

Described and figured by Jordan and Snyder[4] from a specimen taken at Honolulu by Professor Edward Lincoln Moseley. The same species is recorded by Fowler as *Gonorhynchus gonorhynchus*, from which Australian species it differs in the longer head, —4 in length to base of caudal, and in the shading of the fins, the dark area being less extended.

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[4] Journ. Wash. Acad. Sci., vol. 13, Sept., 1923, p. 347.

Family CONGRIDAE

Genus CONGER Cuvier

CONGER WILSONI (Schneider).

Recorded from Honolulu by Fowler. A species described from Australia, unknown to recent writers.

Family MURAENIDAE

Genus GYMNOTHORAX Bloch

The genus *Gymnothorax* may ultimately prove to be divisible into several genera, perhaps, however, not wholly along the lines attempted by McClelland, Kaup, and others. Two species, *Muraena nudivomer* Günther, and *Gymnothorax xanthostomus* Snyder have no teeth on the roof of the mouth. These have been separated by Fowler from *Gymnothorax* proper, under the generic name of *Ahynnodontophis*, the type being *Gymnothorax stigmanotus* Fowler[5] from the West Indies.

GYMNOTHORAX HEPATICUS (Rüppell).

GYMNOTHORAX TILE (Buchanan-Hamilton).

These two Morays are recorded by Fowler from Honolulu.

Genus SIDEREA Kaup

(*Type.—Muraena siderea* Richardson=*Muraena picta* Ahl.)

SIDEREA PICTA (Ahl).

In this abundant species the vomerine teeth are very small, rounded, and arranged more or less in the form of a Y. For the group thus defined the name *Siderea* (later spelled *Sidera*) may be revived. Here belong, in addition to *picta*, other Hawaiian species, *Gymnothorax steindachneri* Jordan and Evermann, *G. hilonis* Jordan and Evermann and *G. nuttingi* Snyder.

Genus ECHIDNA Forster

(*Type.—Gymnothorax echidna* Schneider=*Muaraena nebulosa* Ahl and *Muraena variegata* Richardson).

The Morays with the teeth mostly bluntish, hitherto grouped under the name of *Echidna* Forster, constitute several fairly well marked groups; three of them occur in the waters of Hawaii.

The first is represented by the typical species of the genus *Echidna*, *E. nebulosa* (Ahl). In this, and in others belonging to the same group, there is a single row of conic but sharp canines in the front of the upper jaw, one or two rows of blunt lateral teeth above, two or three blunt canines on the anterior part of vomer, and a narrower band of molars in but one or two series running back along the

[5] Proc. Acad. Nat. Sci. Phila., vol. 64, p. 29. 1912.

middle line of the posterior portion of vomer, the remainder of the roof of the mouth being bare. The vertical fins are well developed, and the body is variously mottled rather than barred. In this section belongs also *Gymnothorax catenatus* Bloch, a West Indian form with similar dentition, the type of *Poecilophis* Kaup, a synonym of *Echidna*. For these species the name *Echidna* should of course be retained.

LEIHALA E. K. Jordan, new genus

(*Type.—Poecilophis tritor* Vaillant and Sauvage=*Echidna leihala* Jenkins.)

The second group of species, hitherto placed under *Echidna*, is distinguished by an extreme development of molars in the roof of the mouth. Lateral teeth and anterior canines similar to those of *Echidna nebulosa;* posterior part of the roof of the mouth, however, covered by a broad plaque of rounded, pebble-like teeth in 5 to 10 series; in youth somewhat fewer series are developed than in old age; however, even in very young specimens (typical *Echidna leihala* Jenkins) the whole width of the palate is covered by molars; anterior part of vomer supporting two or three conic but sharp canines, these apparently lost with age, in *L. tritor* at least; vertical fins well developed; body finely speckled, often more or less barred with black.

LEIHALA TRITOR (Vaillant and Sauvage).

Plate 1, figs. 1, 2

(*Echidna leihala* Jenkins.)

A fine specimen of this species, about 3 feet in length, and very much larger than any examined by Jenkins, was obtained in the Honolulu market. Teeth as in the genus, the lateral teeth above in but one series, the plate of vomerine teeth very large, in many (8 to 10) series. Ground color of body gray, finely flecked, speckled, dusted and reticulate all over with purplish brown; belly, back, head and fins all colored and shaded alike, no vestige of bars anywhere in life or after preservation in spirits. Angle of mouth slightly darker. In Jenkins's types of *Echidna leihala*, very much smaller, a few crossbars appear toward the base of the tail. Otherwise, his small specimens do not differ from our large one, nor apparently from *Poecilophis tritor*, also described from the Hawaiian Islands.

LEIHALA ZONATA (Fowler).

Certainly distinct from *L. tritor*, though similar in generic characteristics, the vomerine patch narrower, are the following alleged species, all described from Hawaii and all closely related: *Echidna zonata* Fowler (=*E. vincta* Jenkins), *E. psalion* Jenkins, *E. obscura* Jenkins, *E. zonophaea* Jordan and Evermann and *E. sauvagei*

Fowler.[6] Below are given the distinctive characters claimed for these species. The barred forms show large variation in the number and width of the dark cross bands, however, and the alleged differences in dentition should be verified. It has been suggested that all are variants of the East Indian *E. polyzona* Richardson, but the teeth in that species differ considerably from those of the Hawaiian forms.

In *E. psalion* Jenkins, the jaws close completely; the lateral teeth of the upper jaw are in but one series, and the dark cross bands are narrower than the interspaces.

In *E. obscura* Jenkins, the mouth nearly closes, the lateral teeth above are in two series, and the obscure dark bands are very much wider than the narrow interspaces.

In *E. zonata* Fowler (= *vincta* Jenkins), the mouth does not fully close; the lateral teeth above are in one series; and the sharply defined black bands are about as wide as the speckled or mottled pale interspaces.

In *E. zonophaea* Jordan and Evermann, the mouth does not close, the lateral teeth above are in a single series; and the dark bands are about as wide as the pale, much speckled interspaces. This form is close to *E. zonata* and is probably the same, but for the present we may accept all four, rather than exchange one doubtful opinion for another. The oldest name of all is *zonata* of Fowler, 1900.

In *E. sauvagei* Fowler, the jaws close completely, the lateral teeth above are in one outer series and three series within; vomerine plaque large, of three or four series; body with 24 dusky crossbands with diffuse edges, and about as broad as interspaces; angle of mouth black. This species seems midway between *L. tritor* and *L. zonata.*

In *E. polyzona* there are no canines in either jaw; the arrangement of the teeth is much the same as in the above species, but all are reduced to molars, and the teeth on the back of the vomer are fewer and somewhat separated. They are scattered across the whole width of the roof of the mouth, however. The lateral teeth above are in two series, and the dark brown crossbands are very much broader than the yellow interspaces. None of the Hawaiian morays seen by me can belong to this species although Fowler records it from Hawaii.[7]

Genus GYMNOMURAENA Lacépède

(*Type.—Gymnothorax zebra* Shaw, 1797.)

Another moray generally included in *Echidna*, but differing considerably from the others, was called *Gymnothorax zebra* by Shaw, and is the type of *Gymnomuraena* Lacépède as restricted by Kaup.

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[6] Proc. Acad. Nat. Sci. Phila., vol. 64, p. 30. 1912.

[7] Idem.

It is characterized by the very slight development of the vertical fins, which are obscured by thick skin, and by the teeth, which are wholly molar, with no canines in either jaw. The lateral teeth are in several series in the upper jaw, and the whole roof and floor of the mouth are paved with small, rounded teeth in about 6 series above and 4 below, close set and suggesting cobblestones. In the upper jaw this paved area extends from the tip, where it is slightly expanded, back into the throat; below the arrangement is similar, but the patch forks narrowly behind. As stated above there are no canines, and the mouth is not wholly closing. For this group the name *Gymnomuraena* Lacépède must be restored. It originally included the genus *Uropterygius* also, but it was restricted by Kaup in 1846, to *zebra*.

Family BOTHIDAE

Genus PLATOPHRYS Swainson

PLATOPHRYS THOMPSONI Fowler.

Fowler describes this species from Honolulu as an ally of *Platophrys mancus* (Broussonnet). Its rays are D. 86, A. 62; scales 132; 95 tubes. In the abundant species, *Platophrys pantherinus* (Rüppell), the dorsal rays are 92; anal 69; tubes of scales 88; the color much the same.

Family BERYCIDAE

Genus BERYX Cuvier

BERYX DECADACTYLUS Cuvier and Valenciennes.

Recorded by Fowler from Honolulu.

Family HOLOCENTRIDAE

Genus MYRIPRISTIS Cuvier

The discrimination of species in *Myripristis* is very difficult, all of them being bright red in life, and all fading to a similar dull pinkish in spirits, with partial loss of their characteristic markings. The following key will assist in their recognition.

ANALYSIS OF THE HAWAIIAN SPECIES OF MYRIPRISTIS

a^1. Scales large, those bearing pores 30 to 32 in lateral line, a few small scales behind them; dorsal fin with 13 to 16 soft rays; anal with 13 or 14.

  b^1. Edge of opercle and base of pectoral with a black or dark blood-red bar; depth 2.25 to 2.33 in length.

    c^1. Body deep red in life; no broad black areas on vertical fins.

      d^1. Spinous dorsal edged with orange; first soft ray of dorsal, anal and ventral white, the rays behind them clear red, tipped with blackish except in full-grown specimens__________________ murdjan.

d^2. Spinous dorsal deep red throughout in life; no white rays on dorsal, anal, ventral nor caudal________________________________ **berndti.**

c^2. Body chiefly pale bluish or grayish in life; vertical fins each with a broad black area posteriorly______________________________ **adustus.**

b^2. Edge of opercle without black; axil faintly dusky; depth 2.75 in length. **argyromus.**

b^2. Scales smaller, 34 to 42 in lateral line, a few smaller ones behind not counted.

e^1. Dorsal fin with 14 to 15 soft rays; scales 34 to 37.

f^1. Edge of opercle and axil pale, without dark bar; soft dorsal 15; anal 13; scales 37; depth 2.5 in length; colors pale____ **sealei**

f^2. Edge of opercle and axil with a dark bar.

g^1. Fins all red in life; soft dorsal rays 15, anal 14; scales 36. **symmetricus.**

g^2. Fins mostly golden yellow in life, with red shades and edgings; soft dorsal 14; anal 12; scales 34_______**chryseres.**

a^2. Dorsal fin with 16 to 18 soft rays; anal rays 15; scales smaller than in other species, 40 to 43 with pores; edge of opercle and axil of pectoral dark red, becoming black; body and fins deep red, with faint stripes along the rows of scales; outer rays of soft fins white, some yellow shades on dorsal; size averaging smaller than other species. **multiradiatus.**

Of these species, the present collection includes *murdjan*, *berndti*, *symmetricus*, and *multiradiatus*, all of which are common at Honolulu. Of the last two I have nothing to add.

MYRIPRISTIS MURDJAN (Forskål).

This fish, known as U'u, is very abundant, constantly seen in the markets, and usually more common than all other species of *Myripristis* taken together. This is apparently the original *Sciaena murdjan* of Forskål, described from the Red Sea. Rüppell's figure,[8] drawn from a young example from the same region, shows the last rays of dorsal and anal, and the next to outer rays of caudal, very dark red or blackish. This coloration (var. *intermedius* Günther) is shown in the young of *murdjan*, but disappears entirely with age. In *M. murdjan* the developed scales of the lateral line, those bearing pores, are 29 to 32, the soft rays in the dorsal 14. In Rüppell's figure the number of scales represented is much too large, but Klunzinger counts correctly 30 in his material from the Red Sea.

MYRIPRISTIS BERNDTI Jordan and Evermann.

This is certainly a valid species, distinguished from *M. murdjan* by the color. The body is a shade paler than in *M. murdjan*, with paler shades or faint streaks along the margin of each row of scales. (In the figure given by Jordan and Evermann, the pale shades are incorrectly shown as lying along the middle of each scale row.) The dorsal fin in *M. berndti* is plain uniform red, the spinous part red throughout; the first soft ray of dorsal, anal, and caudal is deep

[8] Fische Roth, Meer., p. 86, pl. 23, to fig. 2.

red, never white; the black or blood-red bar on opercle and shoulder is present, but a little fainter than in *M. murdjan*, scarcely encroaching on the shoulder. After a time in spirits, these two species, easily separated in the field, can hardly be told apart, for the bright red on the fins fades to white, and can not be distinguished from what was originally white in life, or what was orange or yellow.

MYRIPRISTIS ADUSTUS Bleeker.

The Bishop Museum contains a fine cast of this well-marked species, made from a specimen taken in the Honolulu market. The body is pinkish or bluish, barely red; posterior part of dorsal, anal, and caudal are broadly black; spinous dorsal with two black stripes with white between; opercle and axil with a black bar; scales 30. This differs from *M. murdjan* mainly in color; the body is perhaps a little deeper. *Myripristis botche* Cuvier and Valenciennes, with the fins all pale, can not be this species, as Day has supposed. It is more likely to be *M. murdjan.*

Genus HOLOCENTRUS (Gronow) Scopoli

In our collections of this interesting genus from Honolulu, I find the identical species recorded by Jordan and Evermann, and in the study of their nomenclature I have reached identical conclusions. The key to the species given by Jordan and Evermann is, however, of little value, and those plates which are copied from Günther's Fische der Südsee (*micropterus*, *erythraeus*, and *punctatissimus*) are not very satisfactory. It is known that the key in question, as well as some others in the Fishes of Hawaii, was not prepared by either of the authors, but by an assistant called in in the press of executive work. The use of the size of the eye as a character to distinguish species is rarely of value. The genus *Flammeo*, based on *Holocentrus marianus* Cuvier and Valenciennes of the West Indies, is probably not tenable. The two species with large mouths found in Hawaii bear little resemblance to *H. marianus.* The subgenus *Sargocentron* Fowler, is better justified.

ANALYSIS OF THE HAWAIIAN SPECIES OF HOLOCENTRUS

*a*¹. *Sargocentron.* Body robust, the depth 2⅖ in length; entire body and fins deep brick red, the sides without pale stripes; faint shadings of yellow on the soft fins; dorsal spines low, subequal.

- *b*¹. Opercular spines two, both strong; an area behind eye and in axil of pectoral deep red; back of caudal peduncle with a quadrate white blotch, disappearing with age; depth 2⅖ in length; size large; D XI, 16; A. IV, 11; scales 46 .... spinifer.

*a*². *Holocentrus.* Body more elongate, the depth 2⅗ to 3 in length; sides more or less distinctly striped with white, yellow, or blackish; no white blotch behind dorsal.

- *c*¹. Opercle with two spines, besides minor serrations.

d[1]. Spinous dorsal with a large roundish black blotch on the first three spines; the remainder of fin rosy-silvery with a row of white spots at base; horizontal stripes on body dusky, consisting of rows of blackish spots, these actually aggregates of minute black punctations and not developed in the young, small specimens being faintly striped with silvery; no yellow on body anywhere; opercular spines small, subequal; preopercular spine short; anal spine strong; body more slender than in other species; mouth large, the maxillary reaching to below middle of eye__ **sammara.**

d[2]. Spinous dorsal without distinct black blotch anteriorly on a fin otherwise pale; horizontal stripes on body white, silvery, or yellow.

e[1]. Horizontal stripes along sides of the body white on a red ground; lower opercular spine not longer than upper.

f[1]. Spinous dorsal uniform dark red; opercular spines sharp, the upper much the longer; body relatively slender; stripes on body sharply marked; no yellow in life______ **xantherythrus.**

f[2]. Spinous dorsal variously shaded or spotted, not uniform red; size small.

g[1]. Spinous dorsal very dark red to black, with a curving or broken stripe of white along its middle; body relatively robust; upper opercular spine strong, longer than lower; stripes strongly marked__________________________ **diadema.**

g[2]. Spinous dorsal not as above; opercular spines short, subequal.

h[1]. Dorsal fin low, the spines subequal, and the profile of the fin little convex, the fin red, with a row of pale spots along the membranes mesially; stripes on body not sharply defined; mouth rather large________ **erythraeus.**

h[2]. Dorsal fin higher, its outline more convex; dorsal margined above with blood red, this color becoming black in spirits; body pale, the white stripes rather conspicuous; mouth small; preopercular spine short; opercular spines small.

i[1]. Body not dusted over with blackish dots; snout rather pointed; dorsal with a broad pale median shade, the base darker; anal spine strong, longer than the soft rays ___________________________________ **microstomus.**

i[2]. Body usually largely dusted over with fine dark specks or punctulations; opercular spines insignificant; anal spine slender, sometimes shorter than the soft rays, sometimes longer (*gracilispinis* Fowler); smallest of the Hawaiian species________________ **punctatissimus.**

e[2]. Horizontal stripes on body bright golden yellow; lower opercular spine longer than upper, both sharp; body rather slender; mouth large, the maxillary reaching to opposite middle of eye; anal spine strong; spinous dorsal golden red, the membranes of the first two spines blood-red; axil of pectoral pale. **scythrops.**

c[2]. Opercle with a single strong spine; color bright red; the horizontal stripes golden (becoming white in spirits); spinous dorsal low, even, yellowish red; soft fins with pale borders; axil of pectoral dark red; preopercular spine moderate; anal spine rather short and slender; body rather deep; mouth large, the maxillary reaching to below the middle of the eye; eye large________________ **ensifer.**

Family EXOCOETIDAE

Genus CYPSELURUS Swainson

CYPSELURUS SPILOPTERUS (Cuvier and Valenciennes).

Recorded by Fowler from Honolulu.

Notwithstanding their abundance, swarming everywhere in the open seas about Honolulu, no flying fishes were brought into the market during my stay. Fishermen said that it did not pay to go after them.

Family CENTRISCIDAE

Genus AEOLISCUS Jordan and Starks

AEOLISCUS STRIGATUS (Günther).

Recorded as *Centriscus strigatus* by Fowler.

Family SYNGNATHIDAE

Genus CORYTHOICHTHYS Kaup

CORYTHOICHTHYS MATAAFAE Jordan and Seale.

Of this Samoan species, two specimens were obtained by Fowler from Waikiki Beach.

Family GADIDAE

Genus PHYSICULUS Kaup

PHYSICULUS GRINNELLI Jordan and Jordan.

This is probably the species recorded as *Physiculus kaupi* Poey by Fowler. That species from Cuba has the dorsal rays 10–60, the anal 60 (D. 73 in *grinnelli;* A. 65). The species of this genus, scantily distributed at moderate depths through the warmer parts of both oceans—*dalwigki*, *kaupi*, *japonicus*, and *grinnelli*—are extremely similar one to another. Others in deeper waters are better defined, *fulvus* having much larger scales, *nematopus* produced ventrals and *rastrelliger* numerous (7+18) gill rakers, these structures being few, short and small in all the others.

II

Family SCOMBRIDAE

Genus NESOGRAMMUS Evermann and Seale

NESOGRAMMUS THOMPSONI Fowler.

This interesting fish, represented by a fine cast in the Bishop Museum, is described by Fowler.[9]

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[9] Proc. Acad. Nat. Sci. Phila., vol. 64, p. 376.

Family THUNNIDAE

Genus THUNNUS South

THUNNUS THYNNUS (Linneaus), Ahi.

This great Tunny or Tuna of Hawaii and Japan, possibly distinct from *Thunnus thynnus* of the Atlantic, grows to a very large size, one individual having been seen weighing 580 pounds; unfortunately fins and finlets had been removed. As in the young of the Tunny, immature individuals of 3 feet in length or less have the sides marked by narrow cross-streaks of dull silver, broken up below into whitish spots.

Pectorals reaching two-thirds distance to anal and falling an inch short of soft dorsal, 1½ in head, not edged with darker; dorsal lobe 2⅛ in head, its edge as well as that of anal darker; finlets 7/7, dull yellow, clearly edged with black.

In Japanese specimens, called *Thunnus orientalis*, Doctor Jordan found the dorsal finlets bluish, the anal dull yellowish, the finlets 8/9, gill rakers below 13, dorsal spines XIII to XV. Steindachner's *Orcynus schlegeli* is the young of the species.

The only distinction apparent between *Thunnus orientalis* and *Thunnus thynnus* seems to lie in the color of the finlets, which, in *T. thynnus*, are dark bluish, colored like the back. Perhaps they grow darker with age.

The European Tunny (*thynnus*) has the finlets 8 or 9 above, 7 or 8 below.

Genus GERMO Jordan

GERMO ALALUNGA (Gmelin).

(*Scomber germo* Lacépède; *Thynnus pacficus* Cuvier and Valenciennes.)

The common Albacore has the finlets bluish, without trace of yellow. It was not observed by me, but is recorded as seen by Jordan and Jordan in 1921.

Germo argentivitattus (Cuvier and Valenciennes), mentioned by Jordan and Jordan, should be dropped from the list. The specimen noted by Mr. Nichols was obtained by Dr. Evermann in Peru.

Genus PARATHUNNUS Kishinouye

PARATHUNNUS SIBI (Schlegel).

(*Parathunnus mebachi* Kishinouye.)

This species much resembles *Neothunnus macropterus*, but the dorsal finlets, yellow in the center, are broadly margined with black with a narrow edge of white; the long posterior tip is black. The anal finlets are not yellow, but blackish with a whitish edge, the center sometimes faintly yellow-shaded. Dorsal and anal lobes mod-

erate, 2½ in head. Pectoral long, reaching second dorsal finlet; preorbital narrower than in *Neothunnus macropterus*. Finlets 9/8.

This fish is apparently identical with the Shibi or Mebachi (wasp-eye) of Japan. It is common in the markets both of Hawaii and Japan. These large fishes are rarely obtained by native Hawaiian fishermen, but are secured in great numbers by the adventurous Japanese, who go far out to sea, and who now monopolize the island fishing.

Genus NEOTHUNNUS Kishinouye

NEOTHUNNUS MACROPTERUS (Schlegel), Ahi.

The yellow finned Albacore is abundant in deep water about Hawaii; common also in Southern Japan and about the Santa Barbara Islands of California.

This species is known at once by its bright lemon yellow finlets colored alike above and below, each one anteriorly edged with a narrow line of black; pectoral edged with black, a little longer than head and reaching almost to the second anal finlet; dorsal very high, 1 $\frac{9}{10}$ in head, the lobes of dorsal and anal dull yellow, edged with black; finlets 8/9. Preorbital broad. No crosslines of spots on body; some elongate spots of dull silvery sometimes present.

Genus KATSUWONUS Kishinouye

KASUWONUS PELAMYS (Linnaeus), Aku.

This species, the Aku or Oceanic Bonito, is the most abundant of the large fishes in the Honolulu markets. It runs in great schools in the open sea, where it probably spawns. Young fishes of this, or other Tunnies and Albacores are almost never seen about Honolulu, and they probably cast their spawn in the open sea. I have a report apparently authentic, of a school of Aku, 96 miles long, once passing Hawaii.

The flesh of the Aku is coarse and very red. About one fourth the catch is used as bait for larger and better species; much of the rest is canned as Tuna.

Genus EUTHYNNUS Lütken

EUTHYNNUS ALLETERATUS (Rafinesque).

This species, the Kawakawa of the markets, is a shore fish breeding in the shallow waters of Hilo Bay, which is lined with lava sand, not with coral.

Family ACANTHOCYBIIDAE

Genus ACANTHOCYBIUM Gill

ACANTHOCYBIUM SOLANDRI Cuvier and Valenciennes.

This huge mackerel, called Ono, which reaches a length of 6 to 8 feet, is now common in the markets of Honolulu, being brought in

by the open-sea fishermen. Its flesh is white and excellent. The peculiar network structure of the gills, like that of the sword-fish (*Xiphias*), the laminae of each arch joined into one plate by reticulations, probably justifies the recognition of this genus as type of a distinct family. The same structure of the gills occurs in *Istiophorus* and *Tetrapturus*.

Family GEMPYLIDAE

Genus RUVETTUS Cocco

RUVETTUS TYDEMANI (Weber).

Ruvettus pretiosus JORDAN and EVERMANN (not of Cocco, Osservationes Peloritani, vol. 13, p. 18, 1833.)

Ruvettus tydemani WEBER, Fische *Siboga* Exped., p. 401, 1913.

Ruvettus pacificus JORDAN and JORDAN, Memoirs of Carnegie Museum, vol. 10, no. 1, 1922, p. 34.

This rare species, the Walu of the fisherman, was first described as distinct from the Atlantic species, *R. pretiosus*, by Weber in 1913. The name *tydemani* has priority over our designation of *R. pacificus*.

Family ISTIOPHORIDAE

Genus TETRAPTURUS Rafinesque

TETRAPTURUS MITSUKURII Jordan and Snyder, A'u.

The spear-fish or marlin-fish, known as A'u, seems to be the same as the Japanese species *T. mitsukurii*, and also identical with the form found in Southern California and in New Zealand, no differences appearing in photographs. It needs comparison with *Tetrapturus audax*[10] (Philippi) from Chile, as well as with the Mediterranean species, *Tetrapturus belone* Rafinesque. Both names, *belone* and *audax*, have priority over *mitsukurii*. The still earlier name *imperator* of Schneider, was based on a bad drawing of the sword-fish, *Xiphias*. According to Lütken all the species of *Tetrapturus* are reducible to two, *Tetrapturus belone* of the Atlantic and *T. herscheli* of the Pacific, the latter described from the Cape of Good Hope (1838). A still earlier Pacific name is that of *Tetrapturus indicus* (Cuvier and Valenciennes, 1831), from a drawing made in Sumatra. Probably our species will ultimately stand as *Tetrapturus indicus*, but as there is little gain in substituting one doubtful opinion for another, we may provisionally retain the name *Tetrapturus mitsukurii* for the species of the North Pacific.

Genus CARANX Lacépède

Teeth unequal, some of them enlarged; lateral line strongly arched in front.

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[10] *Histiphorus audax* Philippi, Anales de la Universidad de Chile, vol. 81, p. 35, 1887, pl. 8, Iquique, Chile. Color dark, with whitish cross streaks as in *T. mitsukurii*.

CARANX MELAMPYGUS Cuvier and Valenciennes, Ulua.

This species is the common Ulua, one of the most valued food fishes throughout the South Seas.

It may be distinguished from near relatives by its soft dorsal of 25 soft rays, the anal of 19, and by the completely scaled breast, a character shown also by *Caranx stellatus*, the common and almost equally valued Omilu. In *Caranx melampygus* the pectorals are bright clear yellow in life, the ventrals white, the anal and dorsal pale at base, their produced tips black, the distal portion of the anal especially so, and there are never any black spots or blotches on the body. The longest dorsal ray is a little more than half base of the soft fin, and about the same in depth of body. According to Doctor Wakiya[11] *Caranx bixanthopterus* Rüppell, from Southern Japan differs from *Caranx melampygus* in having the lobe of the soft dorsal $2\frac{1}{6}$ in the base of the fin. *Caranx bixanthopterus*, as thus defined, has not been found in Hawaii. This species was wrongly called *Caranx forsteri* in Jordan and Evermann's Fishes of Hawaii (p. 191).

CARANX STELLATUS Quoy and Gaimard.

(*Caranx melampygus* Günther and Jordan and Evermann, not of Cuvier and Valenciennes.)

The Omilu, one of the largest members of this genus and a valued food-fish, is closely related to the Ulua. It may be known at all ages by the dusky ventral fins and the presence of small scattered black spots over the body. The young are silvery, like the Ulua, but with age the color becomes dusky, and the irregular black spots more numerous and larger. In the young, the pectorals are pale, with a median yellow stripe, becoming dusky with age. The dorsal, anal, and ventrals are entirely black in the adult. Dorsal lobe about as in the Ulua, $1\frac{1}{4}$ in head in adult, $1\frac{1}{5}$ in young.

CARANX MARGINATUS Gill.

This species, not rare at Honolulu, much resembles *Caranx melampygus*, but the soft rays of the anal number 16 instead of 19, and the dorsal rays are 22. The soft dorsal is throughout broadly edged with black, the anal pale, with a row of darker spots at base, along the tips of the interhaemals; caudal edged with dark; ventrals and pectorals pale; a black spot in the axil; a small black opercular spot.

In the account of *Caranx marginatus* of Jordan and Evermann,[12] from Panama, the soft rays of the dorsal are given as 19, the anal 15. The usual numbers, as recorded by Gilbert and Starks, run higher (D. 20 or 21; anal 16 or 17), agreeing in this regard with

[11] Ann. Carnegie Mus., vol. 15, p. 191, 1924.
[12] Fish. North Mid. Amer., vol. 1, p. 922, 1896.

the Hawaiian fish (D. 22, A. 16). The anal in the American fish is golden yellow in life.

CARANX IGNOBILIS (Forskål).

This common species, the Pau'u'u, is known from other Hawaiian forms of *Caranx* by the naked breast with a small patch of scales in the center as in its Atlantic analogue, *Caranx hippos* (Linnaeus). In the life the pectoral and ventral fins are pale, both dorsals and caudal edged with blackish, the anal and lower lobe of caudal bright yellow, no black spot on lower rays of pectoral.

This fish is very close to *Caranx hippos*, but in that species the adult always has a black blotch on the lower part of the pectoral.

CARANX XANTHOPYGUS Cuvier and Valenciennes.

Doctor Wakiya regards *Caranx rhabdotus* Jenkins as identical with *Caranx xanthopygus* which is not unlikely. He regards *Caranx sexfasciatus* Quoy and Gaimard as a distinct species identical with *Caranx flavocoeruleus* Schlegel of Japan.

CARANX KUHLII Bleeker.

To the list from Hawaii, Mr. Fowler adds *Caranx kuhlii* Bleeker, an ally of *Caranx marginatus.*

CARANX LUGUBRIS Poey.

Fowler adds this West Indian species also to the fauna of Hawaii. The body and fins, the pectoral excepted, are sooty black. The fish was obtained from the Clarion Island, but the Pacific form needs farther comparison with the types from Cuba.

Genus URASPIS Bleeker

Teeth in the jaws in a single series, none on vomer or palatines, spines on scutes directed forward.

URASPIS HELVOLA (Forster).

This species is referred to by Wakiya to the genus *Uraspis.*

URASPIS CHEILIO (Snyder).

This species, notable for its thick lips, reaches a length of 3 feet or more. It was three times seen in the market, but owing to its large size only the head of one example was taken away. Only the type, 30 inches long, was previously known.

Genus CARANGOIDES Bleeker

Teeth small, even, persistent; lateral line little arched anteriorly; breast naked.

CARANGOIDES JORDANI Nichols.

(*Carangoides ferdau* Jordan and Evermann, not *Scomber ferdau* Forskål.)

This species, the Ulua Omilu of fishermen is an important food fish of Honolulu, reaching a considerable size. It is distinguished

from *Carangoides ferdau* by the numbers of rays (D. 20; A. 16, instead of D. 23, A. 19) and by its dusky colors, the sides always with a few rather large irregular bronze spots; pectorals pale, other fins mostly dusky. The species needs comparison with others of the same genus found in the East Indies.

CARANGOIDES DASSON (Jordan and Evermann).

This species, with the teeth all villiform, should be placed in *Carangoides* (not *Caranx*).

Genus HYNNIS Cuvier

HYNNIS AJAX (Snyder).

The very large fish, described by Snyder as *Carangoides ajax* and figured by Jordan and Evermann, belongs to the group called *Hynnis* Cuvier and Valenciennes, which differs from the earlier genus *Scyris* Cuvier only in the lack of filiform rays in the second dorsal, perhaps a matter of age. *Hynnis ajax* is close to *Hynnis hopkinsi* Jordan and Starks, from Mazatlan, differing mainly in the rather more slender form. A single example 3 feet long was seen in the Honolulu market, but not taken. It would be interesting to know the changes with age in this species. Except for the much more elongate form of the body and the lack of produced rays in the known examples, *Hynnis* scarcely differs from *Alectis*. But the type specimens of each of the known species of *Hynnis* (*goreensis*, the type of the genus, *cubensis*, *hopkinsi*, and *ajax*) were 2 to 3 feet in length. In none is there any trace of spinous dorsal, or of filaments on the fins.

But the filaments disappear in very old examples of *Alectis ciliaris*, as sometimes seen in the market of Honolulu, one such having been sent by us to the American Museum. *Alectis* has, however, the body much deeper, at all ages, than in *Hynnis* (2¾ to 3 in *Hynnis*, 1⅕ to 2 in *Alectis*, 2⅖ in the type of *Scyris*).

To avoid changing a doubtful opinion for another, I retain the name *Hynnis* for this genus though it may eventually be merged in *Scyris*, or both in *Alectis*.

In Fowler's supplementary list he records "*Scyris indica* Rüppell" which corresponds to the form just mentioned as the probable adult of *Alectis ciliaris*, the depth 2 in length. *Hynnis ajax* has the depth about 3 in length, and no black spot on the upper angle of the opercle, a trait which appears in all or nearly all the fishes referred to *Alectis* and *Scyris*.

Hynnis may be characterized as follows: Head naked; body rather elongate, the depth about one-third length, naked except for an area along lateral line with smooth imbedded scales; profile of head convex; mouth moderate, with villiform teeth on jaws, vomer,

palatines and tongue, dorsal and anal little elevated in front, without filamentous rays so far as known; the dorsal with 18 or 19 soft rays, the anal with 15 or 16. Scutes few and weak, spinous dorsal disappearing with age; lateral line strongly arched.

Genus TRACHUROPS Gill

TRACHUROPS MAURITIANA (Quoy and Galmard).

(*Trachurops crumenophthalmus* Jordan and Evermann.)

In Wakiya's subdivision of (*Trachurops* Gill) the common Hawaiian Akule is referable to *Selar mauritianus.* The earliest restriction of *Selar* Bleeker to *Caranx boops* Bleeker can not hold, as *boops* is not one of the species originally named by Bleeker, under *Selar.* The proper type is *Caranx hasselti*=*Caranx affinis*, and the name *Selar* must replace *Atule* Jordan and Jordan.

Genus SCOMBEROIDES Lacépède

SCOMBEROIDES TOLOOPARAH (Rüppell).

The common Lae of the Hawaiian markets corresponds to *Scomberoides moadetta* Ehrenberg, 1831, in Wakiya's classification. But *S. tolooparah* of Rüppell (1828), described also from the Red Sea, seems to be the same fish, as indicated by Jordan and Evermann. The more slender form, called *Scomberoides sancti-petri*, was not seen by us.

Family BRAMIDAE

Genus TARACTES Lowe

TARACTES STEINDACHNERI (Döderlein).

Recorded by Fowler.

Family NOMEIDAE

Genus CUBICEPS Lowe

(*Ariomma* Jordan and Snyder.)

The genus *Ariomma* differs from *Cubiceps*, if at all, in the rather larger scales, 55 in A. *lurida*, 60 to 66 in *Cubiceps.*

Fowler describes another species of these fragile fishes as *Cubiceps thompsoni.* It differs from *Cubiceps luridus* in having 14 rays in the soft dorsal instead of 17. *Cubiceps evermanni* Jordan and Snyder, also from Hawaii, has a blunter head and larger scales than either of the others.

Family SERRANIDAE

Genus STEREOLEPOIDES Fowler

STEREOLEPOIDES THOMPSONI Fowler.

A huge "jewfish," 6 or 7 feet in length, described as new by Fowler.

Genus EPINEPHELUS Bloch

EPINEPHELUS SEPTEMFASCIATUS Thumberg.

This Japanese species is added by Fowler. Hitherto but one species of this widespread genus, *E. quernus*, has been noted in Hawaii.

Genus CAESIOPERCA Günther

CAESIOPERCA THOMPSONI Fowler.

An interesting new species described by Fowler.

Genus ODONTANTHIAS Bleeker

ODONTANTHIAS ELIZABETHAE Fowler.

Another bright colored fish described by Fowler.

Genus CAPRODON Schlegel

CAPRODON SCHLEGELI Günther.

Omitted by inadvertance in the record of Jordan and Jordan. Described, with a colored plate, by Jordan and Snyder[13], from a specimen from Honolulu, the only one known from the Hawaiian Islands. According to Tanaka, this specimen and the one described earlier by Jordan and Richardson from Japan, belong to a species distinct from *C. schlegeli*, which he names *Caprodon affinis*.[14] *C. affinis* is figured as having the body a little more elongate, and the blackish blotches along the back extending, with interruptions, along the whole base of the dorsal, while in *C. schlegeli* they are confined to the posterior part of the spinous dorsal. On the Hawaiian specimen, figured by Jordan and Snyder, there is no black either on the dorsal fin or on the back. This color probably disappears with age, and *Caprodon affinis* would seem to be the young of *Caprodon schlegeli.*

CAPRODON LONGIMANUS Günther.

This species is recorded by Fowler.

Family PRIACANTHIDAE

Genus PRIACANTHUS Cuvier

PRIACANTHUS JAPONICUS Cuvier and Valenciennes.

Two specimens of this large and handsome fish were secured. This is with little doubt the form recorded by Fowler as *P. boops* Schneider, following Boulenger, who unites all the large *Priacanthi* of both oceans under this name. *P. boops* was originally described from the South Atlantic; it has about 95 scales in longitudinal series, about 60 along lateral line and only 12–13 dorsal and anal

[13] Bull. U. S. Bur. Fish., vol. 20, p. 211, 1906.

[14] Fig. and Desc. Fishes Japan, vol. 33, Aug. 24, 1924, p. 611, pl. 158, fig. 408.

rays. *P. japonicus* is related, but has fewer scales (about 80, lateral line 40–45), and more fin rays. Our specimens agree well with an example of this species from Japan. Color bright red all over, the tips of the fins black; ventral fins very long; body deep, 2½ or less in length; Length 2 feet, a much handsomer and more powerful looking fish, with larger scales, than others of the genus.

Family APHAREIDAE

Genus APHAREUS Cuvier and Valenciennes

APHAREUS THOMPSONI Fowler.

Described as new from a specimen obtained in the Honolulu fish market by John W. Thompson, the artist of the Bishop Museum. It has gill rakers 18+24, while *A. furcatus* Cuvier and Valenciennes has but 6+16. In the nominal species, *Aphareus flavivultus* Jenkins, there are 5+15.

III

Family HISTIOPTERIDAE

Genus HISTIOPTERUS Schlegel

HISTIOPTERUS TYPUS Bleeker.

Fowler records a specimen from Hilo, perhaps the one of which the cast was noted by Jordan and Jordan.

Family SCORPAENIDAE

Genus MERINTHE Snyder

MERINTHE MACROCEPHALA (Sauvage).

In this species we find a surprising variation in the development of the orbital cirrus. In some especially large examples this appendage is long, worm-like, more than half the length of head. In others it is variously shorter, about as long as eye, as in the figure given by Jordan and Evermann (p. 461, pl. 55). In still others, it is reduced to a small black filament much shorter than pupil, and in some small individuals it is not traceable at all. Those with the shorter filaments are smaller in size, presumably younger. No other difference can be found on the specimens.

This species, taken from deeper water with *Etelis*, *Etelinus*, and other red fishes, is in life bright scarlet, with dark olive or blackish dots and markings. It is remarkable for the great length of the head which is nearly, not quite, as long as the rest of the body.

Genus IRACUNDUS Jordan and Evermann

IRACUNDUS SIGNIFER Jordan and Evermann.

A third specimen of this rare species is recorded by Fowler.

Genus TAENIANOTUS Lacépède

TAENIANOTUS TRIACANTHUS Lacépède.

Recorded by Fowler.

Family DACTYLOPTERIDAE

Genus DACTYLOPTENA Jordan and Richardson

DACTYLOPTENA ORIENTALIS (Cuvier and Valenciennes).

I can detect no difference between our specimens of this species from Honolulu and others from Japan.

Family ZEIDAE

Genus ZENOPSIS Gill

ZENOPSIS OCELLATUS (Schlegel).

Fowler records this Japanese species.

Family CHAETODONTIDAE

Genus CHAETODON Linnaeus

CHAETODON SEMEION Bleeker.

A fine cast of this showy species is in the Bishop Museum.

CHAETODON RETICULATUS Cuvier and Valenciennes.

A cast of this handsome species, known by the bright red color of the posterior part of the anal, is in the Bishop Museum. This is the species recorded by Fowler as *Chaetodon collaris*, as it is the *Chaetodon collaris* of Günther, but not of Bloch nor of Schlegel. Bloch's species, recorded, doubtfully, from Japan, is probably *Chaetodon praetextatus* of Cuvier and Valenciennes, of the East Indies. The species called *Chaetodon collaris* in Japan is different from either and should stand as *Chaetodon auripes* Jordan and Snyder, the earlier name *aureus* being preoccupied in *Chaetodon*.

CHAETODON LINEOLATUS Cuvier and Valenciennes.

In Günther's figure (Fische der Südsee), copied from Garrett, the narrow crosslines like pencil marks in this species are represented as very oblique, directed forward below. Actually, however, as stated in various descriptions, these lines descend almost vertically.

CHAETODON FREMBLYI Bennett.

This species, notable for its blue markings and for the absence of the orbital bar, I found fairly common at Honolulu, only the small *Chaetodon miliaris* exceeding it in abundance.

Genus TIFIA Jordan and Jordan

TIFIA CORALLICOLA (Snyder).

Several specimens of this rare species were obtained from the reef.

Genus HEMITAURICHTHYS Bleeker

HEMITAURICHTHYS POLYLEPIS Bleeker.

Recorded by Fowler.[15]

HEMITAURICHTHYS THOMPSONI Fowler.

Described as new by Fowler.

Genus CHAETODONOPLUS Bleeker

CHAETODONTOPLUS ARCUATUS (Gray).

A specimen, the second known, recorded by Fowler.

Genus CENTROPYGE Kaup

CENTROPYGE FLAVISSIMUS (Cuvier).

A specimen of this brilliantly yellow fish of the South Seas recorded by Fowler. Body and fins entirely yellow, except for blue edgings and lines. A small example supposed to be of this species was seen in 1921 in the aquarium at Waikiki.

Family ACANTHURIDAE

Genus ACANTHURUS Forskål

(*Hepatus* Gronow; *Teuthis* Linnaeus in part, not as usually restricted.)

ACANTHURUS NIGRICANS (Linnaeus).

Recorded by Fowler.

ACANTHURUS THOMPSONI Fowler.

Described by Fowler.[15] A species everywhere almost black, with a jet black blotch in its axil below.

Family LABRIDAE

Genus DIASTODON Bowdich

(*Type.—Diastodon speciosus* Bowdich=*Labrus scrofa* Cuvier and Valenciennes.)

DIASTODON MODESTUS Garrett.

This species, reported by Fowler, we have never seen. The figure by Garrett[16] shows small scales (about 53) and a large white blotch below last rays of dorsal. The species can not therefore be referred to *Lepidaplois*, in which genus the scales are about 33. It seems to accord generically with the type of *Diastodon*.

Genus LEPIDAPLOIS Gill

(*Gymnopropoma* Gill.)

The fact that in the type of *Lepidaplois* (*axillaris*) the scales cover most of the preopercle, while in *bilunulatus* (type of *Gymno-*

[15] Proc. Acad. Nat. Sci. Phila., vol. 64, p. 384. 1912.

[16] Fische der Südsee; copied in Jordan and Evermann, Fishes of Hawaii, p. 279.

propoma) the two limbs of the preopercle are almost scaleless, hardly justifies the separation of the group into two genera.

LEPIDAPOLIS ATRORUBENS E. K. Jordan, new species.

Plate 1, fig. 3

Head 3.1 in length; depth 3; snout 2.9 in head; eye 6.7; interorbital 3.4; D. XII, 11; A. III, 12; scales 7–34–13.

Body oblong, stout, not greatly compressed; head longer than deep, upper and lower profiles only weakly convex, almost similar; snout rather long, pointed; jaws pointed, about equal; mouth large; teeth strong, conic; 4 large canines on front of each jaw, and a strong posterior canine tooth; lips fleshy; eye rather large, its posterior margin slightly anterior to middle of length of head; posterior margin of preopercle very finely serrate; interorbital fairly broad, convex; nostrils in front of eye, the anterior smaller, and in a very short fleshy tube; last dorsal spine 4.8 in head; seventh dorsal ray 2.8; third anal spine 4; caudal deeply lunate, the outer rays produced and about one and two-thirds length of the inner, their total length about 1.3 in head; base of caudal broad, about 2 in head; pectoral rather small, about 1.7 in head; ventrals long, pointed, the first few rays greatly produced, their length about 1.2 in head; scales large, thin, flexible, small upon back in front of dorsal fin and along base of dorsal and anal; scales smaller on chest than on rest of body; no scales in front of eye, the interorbital wholly bare, part of head posterior to middle of eye otherwise largely covered with small scales; lateral line nearly concurrent with dorsal profile, uninterrupted, the pores distinct and rather complexly branched.

Color in life somewhat variable. One specimen, the type, had the body a deep wine red, irregularly blotched with very dark brown, approaching black, more dark dorsally than on belly, these blotches arranged in no regular pattern and not corresponding on the opposite sides of the fish; upper part of the body faintly striped longitudinally with lighter and darker, these stripes corresponding to the rows of scales and much more prominent on the darker areas, being formed by a longitudinally oblong light patch on the center of each scale; head reddish brown, lighter and more red in places, darker and browner in others, two diffuse longitudinal streaks running back from eye to edge of opercle, the upper meeting end of lateral line, the chin practically black, with irregular dark red spots; dorsal almost wholly dark or nearly black, a very black spot between the second and third spines; a large, vague black blotch below last rays of dorsal, anal very dark, margined with black; pectoral brown, darker near the base, the axil of pectoral orange; ventrals and caudal black.

Another specimen was dull grayish brown all over in life, the body obscurely longitudinally striped, but generally uniform in color and not heavily blotched with dark, a large vague black patch on back under last rays of dorsal similar to that on *L. albotaeniatus* but more diffuse; head without longitudinal streaks running back from eye; the cheek, and most of opercle dark; chin yellowish brown, darker in places; fins dark brown, but not black, a very prominent black spot between second and third dorsal spines; pectorals lighter in color than other fins, the axil dark rusty red.

Another specimen is in general similar to the above, but the dark blotch under the last rays of dorsal is less evident; black spot between the second and third dorsal spines conspicuous; axil of pectoral rusty.

In spirits the appearance is not greatly altered. The deep red fades more or less, however, becoming a light yellowish brown, with pinkish stains, and the fish becomes generally lighter in color. This species differs from *Diastodon modestus*, which it otherwise somewhat resembles, in the number of scales, 34 in this fish as against 53 in the other. In *D. modestus* a large whitish spot is figured below last rays of dorsal.

Three specimens were taken in the Honolulu market. The type 14½ inches long is Cat. No. 87421, U.S.N.M.; cotypes, 15½ and 17 inches long, are in the collection of Stanford University.

Genus CORIS Lacépède

If this genus is to be further subdivided, the prolongation of the first dorsal spine will perhaps serve better than the size of the scales. The type of *Coris* (*aygula*) has the anterior dorsal spines elevated; no posterior canines; scales 61. In the type of *Julis* (*julis*), the first spines are elevated, a posterior canine is present, and the scales are 75. In the type of *Hemicoris* (*variegata*) the first dorsal spine is lower than the others, a posterior canine is present, and the scales are 52. For the present we may refer all the Hawaiian forms to *Coris*. None of the Hawaiian species has posterior canines. In *gaimardi* (scales 84) the front of the dorsal is elevated; also in *lepomis* (scales 92), *ballieui* (scales 52), and *rosea* (scales 53). The first spine is lowest in *eydouxi* (scales 81), in *flavovittata* (scales 88), and in *greenovii* (scales 78).

CORIS GAIMARDI (Quoy and Gaimard).

(*Coris pulcherrima* Günther.)

Our specimens of this highly colored reef fish are apparently referable to *Coris pulcherrima*. The species is extremely variable and the bands on the head appear to be green, crimson, or violet under different lights. They also vary much in width. Different observers (Günther, Jenkins, Jordan and Evermann) have tried

to show differences between the common form (*pulcherrima*) and the longer known *gaimardi*, but without much success. I believe the two to be identical. Günther mentions a posterior canine in *C. gaimardi*, but I fail to find it.

CORIS VARIEGATA (Rüppell).

This strongly marked species is recorded by Fowler.

CORIS, species indetermined.

In the aquarium at Waikiki I saw a living species of *Coris*, apparently undescribed. The following are its life colors:

Back with obscure broken greenish longitudinal stripes, below lateral line these become rows of quadrate vertical spots much deeper than long; top of head marbled, the sides of head with about three rows of darker blotches on the side; dorsal and anal blue-edged; caudal clouded at base, then black, becoming paler at tip; ear spot blue, rimmed with black. A large fish, looking like *C. lepomis* and with the ear spot as in *C. eydouxii* (blue-black in color), but apparently different from either. The first dorsal spine is elevated.

Genus ANAMPSES Cuvier

ANAMPSES GODEFFROYI Günther.

There can be no doubt that the painting of Garrett, on which the name *godeffroyi* rests, was intended for the fish later called *Anampses evermanni* by Jenkins. Garrett's painting was hastily made, but could represent nothing else.

Family POMACENTRIDAE

Genus CHROMIS Cuvier

CHROMIS SINDONIS Jordan and Evermann.

This fish, not obtained by me, cannot be placed in *Abudefduf*, and is near *Chromis*, from which genus it differs only in having a deeper body than others.

CHRONIS VERATER Jordan and Thompson.

Two specimens of this rare species taken.

IV

Family SCARIDAE

Genus LEPTOSCARUS Swainson

(*Calotomus* Gilbert: *Callyodon* Cuvier and Valenciennes, but not of Gronow, nor of Scopoli, nor of Schneider, the type of these authors being *Scarus croicensis* Bloch, of the West Indies.)

The name *Leptoscarus*, given by Swainson to *Scarus vaigiensis* of Quoy and Gaimard, a near ally of *Leptoscarus irradians*, is the oldest

applicable to the species of this genus. The name *Sparisoma*, for *Scarus abbildgaardi* must apparently be retained for a related genus, although the definitions assigned by Swainson to his various genera of *Scari* are mostly without pertinence.

ANALYSIS OF HAWAIIAN SPECIES OF LEPTOSCARUS

a^1. Color of body and fins dull grayish or brownish.
 b^1. Dorsal fin with a small black spot between first and second spines; caudal somewhat lunate.
  c^1. Sides above lateral line with a series of about five roundish white spots as large as pupil; dorsal also with small whitish markings; sides of body below lateral line with about 10 or 12 large round spots; numerous smaller spots and irregular markings scattered among these ---- **snyderi.**
  c^2. Sides somewhat mottled with lighter but without distinct spots or specks; dorsal obscurely marked with darker, not distinctly spotted with white ---- **sandvicensis.**
 b^2. Dorsal fin without black blotch in front; caudal rounded ---- **cyclurus.**
a^2. Color of body and fins chiefly blue or green; about 8 pale or pink stripes radiating from eye; scales each with a pink spot at base; fins mottled or striped; caudal truncate ---- **irradians.**

LEPTOSCARUS IRRADIANS (Jenkins).

This handsome species is common about Honolulu. Günther[17] is apparently in error in identifying it with *Leptoscarus genistriatus* (Bleeker) of the East Indies. In life, *irradians* is blue and green, the markings on the head pink, while *genistriatus* is a dark red fish much mottled with darker; the head markings figured as a deep red. Except for the general color the patterns on the two are quite similar.

Genus SCARIDEA Jenkins

This genus, with *Sparisoma*, differs from all other Hawaiian *Scaridae* in having stiff dorsal spines. From *Sparisoma* it is distinguished by the few series of nearly free teeth—at most three in either jaw and not coalescent except at the base. The teeth of *Sparisoma* are usually in many series—from six to nine—and all but the outermost are firmly coalescent into a solid plate approaching those of *Scarus* proper, Posterior canines are present in both genera. As far as known, *Scaridea* is confined to the Hawaiian Islands, while, except for one Mediterranean species, *Sparisoma* is found only in the general region of the West Indies.

ANALYSIS OF HAWAIIAN SPECIES OF SCARIDEA

a^1. Body with a broad brassy yellow cross band just back of tip of pectoral; lower part of head irregularly blotched with bright scarlet ---- **aërosa.**
a^2. Body without brassy crossband; no bright scarlet on head.

[17] Fishe der Südsee, vol. 3, p. 300.

b^1. Body rather elongate, its depth less than one-third the length to base of caudal, fins mottled with dusky but not strongly barred; sides of body not spotted with white ____________ farrandi.

b^2. Body rather deep, its depth considerably more than one-third the length.

c^1. Sides of body with scattered pale round spots; anal nearly plain, not strongly barred ____________ balia.

c^2. Sides of body without prominent pale spots, sides obscurely cross-banded with darker; and with three distinct oblique cross bars ____________ zonarcha.

SCARIDEA AËROSA Jordan and Snyder.

Two specimens were obtained in the Honolulu market, and, as the original diagnosis was from preserved material, a description of the life colors is here given.

Ground color of body dull brownish, passing into a bluish gray on belly and somewhat mottled with lighter brown and grayish white, the posterior margin of scales the lighter. A broad, nearly vertical band of greenish golden brassy, four scales in width, on middle of side, narrowing to one scale on belly and back, encircles body between sixth dorsal spine and the scale just before the anal opening.

Head generally brownish like body, but below level of mouth largely covered by an irregularly outlined blotch of bright scarlet, broken by a brown band uniting corners of mouth, and by another across isthmus. An irregular orange line runs up along upper lip, but not completely across snout. Behind eye are a few scattered spots of golden orange; there is no suggestion of regular markings on head however. Axil of pectoral flushed with rose.

Vertical fins dusky, irregularly mottled with lighter and darker; a conspicuous black spot between first and second dorsal spines, another on third from last dorsal ray. Ventrals bluish gray, with faint brownish stains. Pectorals bluish and brownish, touched with greenish gold toward their tips.

Teeth white; some scarlet on inside of mouth.

Another specimen is colored similarly except that the scarlet area on head is slightly less extensive, and the brassy crossband is wider and slopes more obliquely backward.

In spirits, the red colors are at once lost, changing to a dirty grayish, quite inconspicuous. Consequently in the original description and figure no mention is made of the most striking character of the fresh fish. The brassy crossband seems to be reasonably permanent.

This is without doubt the species which Bryan,[18] from a painted cast in the Bishop Museum of Honolulu and the preserved specimen from which the cast was made, described and photographed as "*Scaridea zonarcha* Jenkins, or else new species," but to which he gave no name.

[18] Bryan, William Alanson, Occ. papers of the Bernice Pauahi Bishop Museum, vol. 2, No. 4, p. 35.

SCARIDEA FARRANDI E. K. Jordan, new species.

Plate 1, fig. 4

Head 3.4 in length; depth 3.1; eye 5.5 in head; interorbital 4.5; scales 2-25-5; D. IX, 10; A. III, 9.

Snout blunt, the anterior outline steep between tip of snout and interorbital space, then sloping gently backward to origin of dorsal; jaws nearly equal, the lower slightly included; cleft of mouth not quite reaching anterior edge of orbit; teeth of upper jaw on outer edge of dental plate in 3 series for about half length of jaw, where they are followed by a short space without teeth, then by a single, strong curved canine which projects outward and backward; lower jaw with 3 rows of teeth anteriorly, 2 laterally, and 1 posteriorly; dorsal spines stiff and sharp; little difference in height of spinous and soft dorsals; anal spines rather slender and flexible; anal rays similar in height to soft dorsal, 2.4 in head; dorsal and anal extending an equal distance posteriorly; ventrals rounded; pectoral 1.5 in head; caudal evenly rounded, the middle rays longest; lateral line parallel to dorsal profile to a point below posterior end of dorsal, where it is abruptly bent downward, passing along middle of caudal peduncle; tubes of lateral line prominent and greatly branched; scales on occiput and opercles, a single row passing obliquely downward on cheek below eye; three scales on median line anterior to origin of dorsal.

Color of a specimen after about a month in formalin, light brownish gray, indistinctly mottled with lighter gray, golden brown, and nearly black on occasional scattered scales; belly lighter than sides or back, and brown rather than gray in general color; a narrow blackish line, formed by horizontal dark dashes on the center of each scale, running backward to a point about opposite origin of anal, above, another similar line a little longer but much fainter, below a fairly distinct line a little shorter, and below that, on belly, a faint suggestion of another, making four such lines in all, two of them prominent; no other regular markings anywhere on body; head without regular markings, similar in color to body; no suggestion of the dull whitish color to which scarlet fades; a light yellowish patch between the eyes; iris golden; teeth white; vertical fins pale, faintly mottled with dusky, no distinct dark edgings or bands although dark stains on dorsal are arranged to some extent along oblique crosslines, very faint; no suggestion of banding on anal; a prominent black spot between first and second dorsal spines; pectorals pale, ventrals pale, the tip of first ray blackish.

But one specimen, the type, measuring 9 inches in length, was obtained from the Honolulu market. Its catalogue number is 87416, U.S.N.M.

This species is of the same general type as *Scaridea aërosa* which it resembles almost exactly in outline and other characters, but the two species differ utterly in coloration. *S. farrandi* lacks the golden or brassy crossband, lacks the large scarlet patches about the head, is much lighter in ground color, and shows longitudinal lines upon the lower side. From other species of the genus it differs in the more elongate body and the strongly convex anterior profile.

I take pleasure in naming this species for Dr. Livingston Farrand, President of Cornell University, in recognition of his interest in this collection of fishes.

SCARIDEA BALIA Jenkins.

A second specimen is recorded by Fowler.

SCARIDEA ZONARCHA Jenkins.

A small, deep bodied, compressed species, with strongly obliquely barred anal and generally mottled appearance, known only from three specimens obtained by Jenkins at Honolulu in 1889.

Genus SCARUS Forskål

ANALYSIS OF HAWAIIAN SPECIES OF SCARUS (TEETH NOT BLUE)

- a^1. General life color brownish, dull reddish or dull gray, with little or no blue or green in markings or ground color.
  - b^1. Cheek with but one complete row of scales extending below eye; posterior canine wanting; caudal scarcely emarginate.
    - c^1. Head with scattered light olive spots, and with a light brown divided saddle before eye, this area bordered with greenish blue, and margined with purple ---------- **kraussi.**
    - c^2. Head without distinct markings.
      - d^1. Edge of dorsal and anal marked by a distinct bluish line, turning dusky in spirits ---------- **miniatus.**
      - d^2. Edge of dorsal and anal not marked by a dark line.
        - e^1. Body rather deep, its depth notably more than one-third the length; base of caudal with a pale bar ---------- **ahula.**
        - e^2. Body rather elongate, its depth notably less than one-third the length; caudal fin uniformly shaded, without pale bar at base. **borborus.**
  - b^2. Cheek with two or more full rows of scales below eye; posterior canine normally present, but often wanting; caudal more or less emarginate.
    - f^1. Side of belly with three distinct whitish longitudinal stripes; posterior canine wanting ---------- **dubius.**
    - f^2. Side of belly without distinct white stripes.
      - g^1. General body color dark leaden gray verging on violet; posterior canine usually but not always present.
        - h^1. Upper lip, when fully extended, not completely covering teeth; caudal lunate, with an abrupt white band at tips of rays ---------- **galena.**
        - h^2. Upper lip, when fully extended, completely covering teeth; caudal practically truncate, without white band at tip. **erythrodon.**

g^2. General body color reddish or brown, not dark leaden gray nor violet.

i^1. Caudal fin deeply emarginate; posterior canine usually wanting, occasionally present______________ **brunneus.**

i^2. Caudal fin truncate____________________________ **paluca.**

a^2. General color in life largely brilliant blue or green.

j^1 Head with a broad greenish or purplish saddle before eye, this area continuous from side to side and bordered by bright greenish blue; posterior canine wanting or small; head and fins with elaborate markings of blue and green; caudal subtruncate. **perspicillatus.**

j^2 Head without peculiar markings as above; caudal fin lunate, with produced angles.

k^1. Body relatively slender, the depth 2⅔ to 3 in length; dorsal fin largely red or orange, banded with blue or green.

l^1. Dorsal fin orange, with a broad undulating blue band above, edged above and below with darker blue; blue spots on base of each membrane; anal similar; caudal edged all around with blue. **formosus.**

l^2. Dorsal fin red, with a green median streak and a blue margin; anal similar; caudal with four curved blue cross bands___________ **bataviensis.**

k^2. Body relatively deep, the depth 2½ in length; dorsal fin not largely red or orange.

m^1. Dorsal fin green at base and along edge, the middle portion paler; caudal with green spots. **jenkinsi.**

m^2. Dorsal fin narrowly blue on base and border, the two areas separated by a broad, dusky whitish band; caudal crossed by a subterminal blackish line______________ **gilberti.**

SCARUS KRAUSSI E. K. Jordan, new species.

Plate 2, fig. 1

Head 3 in length; depth 2.7; eye 6 in head, snout 2.6; interorbital 2.7; D. IX, 10; A. III, 9; P. 14; scales 2—24—6.

Body moderately deep, stout, not closely compressed; profile of top of head straight, running into a dorsal profile that is evenly convex from beginning of dorsal fin to caudal peduncle; snout very blunt, as if chopped off, its tip slightly in advance of mouth; mouth on axis of body; jaws unequal, the lower included; teeth pinkish dusky, white at tip; no posterior canine; upper lip double only close to corner of mouth, only covering about half the dental plate; lower lip very narrow, covering less than half the dental plate; cheek with but one complete row of scales; a second lower row is represented by 3 small scattered scales; lower limb of preopercle naked; opercle scaled, scales on lower limb smaller or partially embedded; 4 scales on median line in front of dorsal; lateral line interrupted under base of

last but one dorsal ray, reappearing two scales below and continuing to caudal; tubes of lateral line variously branched, much so on some scales, hardly at all on others; in general the complexity of branching decreases posteriorly.

Dorsal spines flexible, their length about 3.3 in head; dorsal rays slightly elevated, about 3 in head, and similar to soft anal; caudal truncate; ventrals fairly long, about 2.2 in head; pectorals much longer, 1.4 in head, the posterior edge evenly curved and the uppermost rays not produced.

Color in life greenish brown, becoming pinkish below on breast and belly; each scale with a rather broad border of dark reddish brown; on sides of belly the greenish is reduced to light blue spots on a pinkish ground; head somewhat reddish, marked with sky blue; an irregular brown area, vertically oblong, bordered with bright blue and margined with purple before each eye, these two patches not quite united over median line; various light blue and olive spots and dashes on sides of head; lips brownish pink; an irregular, oblong, bluish area behind lower lip, extending to both sides; teeth pale rosy. Pectorals brown, the first ray blue, a dull blue cross streak before base; ventrals light orange, the first ray blue; caudal dusky, the outer rays slightly darker; dorsal with a blue green stripe along base, then light orange, then a diffuse stripe of pale green, then a stripe of darker orange a bit wider than others, a narrow blue black margin; anal similar, the orange and blue brighter.

Color in spirits dull brown, lighter below, the margins of scales lighter; the markings on head retained, but the blue faded to yellowish white and the purple to dusky; teeth rosy brown. Dorsal and anal whitish, margined with dusky, this margin particularly abrupt and prominent on anal, the dorsal obscurely darker at base; pectoral clear, obscurely streaked with brownish, and darker at base; ventrals pale, a little darker on first ray and at tip.

In a general way the life color pattern resembles that of *S. perspicillatus*, but this fish is essentially brownish in life and not bright green. The fins, also, are not banded as in *S. perspicillatus;* the saddle before the eye is more irregular and not continuous over the top of head; and the lower lip lacks the broad, solid band.

A single specimen, the type, 14⅔ inches in length, was taken in the Honolulu market. It is Cat. No. 87417 U.S.N.M. Named for Prof. Frederick G. Krauss, of the University of Hawaii, with whose family the writer resided while in Honolulu, and who kindness and generosity were unfailing.

SCARUS DUBIUS Bennett.

Scarus dubius BENNETT, Zool. Journ., vol. 4, p. 828, no. 13, art. 3, p. 37. Oahu.

Scarus bennetti CUVIER and VALENCIENNES, Hist. Nat. Poiss., vol. 14, p. 270, 1839. Oahu, same example.

Callyodon bennetti JORDAN and EVERMANN, U. S. Fish Comm. Bull., vol. 23, pt. 1, p. 352, with plate. Honolulu.

Pseudoscarus dubius GÜNTHER, Fische der Südsee, vol. 8, p. 313.

This species has passed as *Scarus bennetti* Cuvier and Valenciennes, which name, however, was given somewhat later than *dubius.* The two species are said by Günther to have been founded on the same type specimen. Unfortunately, the name *dubius* was later misapplied to the fish here named *Scarus galena*, and the name *bennetti* accepted for the present form, which is distinguished by the three longitudinal white streaks along side of belly; the ground color is lead gray.

SCARUS GALENA E. K. Jordan, new species.

Pseudoscarus dubius GÜNTHER (not Bennett) Cat., vol. 4, p. 229, 1862.

Callyodon dubius JORDAN and EVERMANN (not Bennett), U. S. Fish Comm. Bull. 23, pt. 1, p. 350, pl. 44, 1903.

Head 3.1 in length; depth 3.1; eyes 6 in head; snout 3; preorbital 5; interorbital 3.2; D IX, 10; A. III; P. 14; scales 2–25–6.

Body moderately elongate, not deep, and not greatly compressed; head short; snout short; mouth small, horizontal, slightly below axis of body, lower jaw included; upper lip covering about two thirds of upper dental plate, lower lip leaving about one-half of lower teeth exposed; a well developed posterior canine in upper jaw of most specimens, this occasionally obsolete or lost; teeth white; eye small, lower edge of orbit in line with axis of body; interorbital space wide, broadly convex; scales large, 4 on median line before dorsal; 2 complete rows of scales on each cheek below eye, a third row occasionally represented by one or two small scattered scales, partially embedded; subopercle with a single row; opercle scaled; lateral line interrupted under last dorsal ray, to reappear again 2 rows farther down, 18 pores in the first and 7 in the last; tubes of lateral line with very short branches.

Dorsal spines soft and flexible, their length scarcely equalling snout; soft dorsal not elevated, the border of the entire fin uniformly rounded; anal similar to soft dorsal, its rays equalling snout; caudal lunate, the outer rays somewhat, though not greatly produced, their relative length variable; pectoral not quite reaching origin of anal.

Color of specimen after about a month in formalin but probably little altered, deep leaden gray, very little lighter on belly, the center of each scale darker; no distinct markings of any kind on body or head; pectorals and ventrals pale; vertical fins all dark and uniform except for the caudal which is abruptly tipped with pale.

Four examples of this species were taken by me in the market of Honolulu.

The type is Cat. No. 87418, US.N.M., taken by me in the market of Honolulu. In the museum of Stanford University are No. 8781, from Honolulu, and 8784, from Samoa. Also 23374, from Honolulu.

This fairly common species is well figured and described in Jordan and Evermann (from whom the above diagnosis is modified) as *Callyodon dubius* Bennett, following Günther. The name *dubius* however, has been shown to belong to the fish later called *Scarus bennetti;* by Cuvier and Valenciennes, and the present form is left nameless.

(*Galena*—lead ore, a dark gray lead sulfid mineral, from the life color.)

SCARUS BRUNNEUS Jenkins.

A specimen about 2 feet in length, apparently belonging to this species, was seen in the Honolulu market. The fish being so large, only the head was taken, but this agrees well with Jenkins's type. The color was dark reddish brown, the vertical fins broadly edged with a dusky wash. An inconspicuous posterior canine is present; in a smaller fish, however, this would easily be overlooked. No specimen of *Scarus brunneus* has previously been reported over 9 inches in length.

SCARUS BATAVIENSIS Bleeker.

Recorded from Honolulu by Steindachner.

Genus PSEUDOSCARUS Bleeker

Those species of *Scarus* having the jaws blue may properly be regarded as generically distinct from those with the jaws whitish or pale rosy. The blue coloration is permanent, is found at all ages, and is not altered by preservation in spirits. It seems to represent a very high degree of specialization. The body coloration in this group, usually, but not always, green or blue, is more specialized than that of *Scarus* proper.

ANALYSIS OF HAWAIIAN SPECIES OF PSEUDOSCARUS

a^1. Caudal rounded or simply lunate.

- b^1. Caudal rounded, bright bluish green; belly pale green with several blue-green longitudinal stripes; upper part of body between pectoral and caudal peduncle yellow; pectoral blue-green; dorsal blue-green, with red stripes ---------- **vitriolinus.**
- b^2. Caudal lunate, red; belly without stripes; body without large yellow area on side; pectoral yellow with the first ray only blue; dorsal red with blue trimmings ---------- **troscheli.**

a^2. Caudal with the outer rays much produced, often more than twice the length of middle rays.

- c^1. Color below as above deep greenish blue, the middle of sides with a rosy shade; head with yellowish streaks below, and another from upper lip to eye; caudal blue-green, the middle rays tipped with orange; pectorals broadly orange behind; orange on base of ventrals ---------- **jordani.**

c^2. Color on lower part of body not deep green nor blue as on back; several streaks radiating from eye.

d^1. Streaks radiating from eye greenish; body brown above anteriorly, posteriorly green; sides salmon red; head with brown and blue markings; dorsal orange, edged with blue and with blue markings; caudal ochraceous, the outer rays blue and green, a subterminal green bar------------------------------ **heliotropinus.**

d^2. Streaks radiating from eye red; body greenish above over whole length; sides pink, becoming yellow below and grayish green on belly; head and snout with irregular red streaks, the upper lip red; dorsal red, with a blue margin and a row of blue spots at or near base; anal blue, with a rosy longitudinal band; caudal with outermost rays blue, the next two red, the inner rays green with a terminal ochraceous bar------------ **xanthopleura.**

PSEUDOSCARUS VITRIOLINUS Bryan.

This species was hitherto known only from a single example. We secured a second in the market at Honolulu. After about a month in formalin it shows the following coloration:

Dorsal–anterior part of body pale yellowish green, the anterior portion of scales lighter, the posterior margin colorless; this greenish becomes more and more yellowish posteriorly till beneath the soft dorsal the sides of the body are a golden brown, with only a very faint greenish cast; caudal peduncle quite abruptly bright blue-green; belly anteriorly similar in color to sides, but striped longitudinally with blue-green, there being three such stripes running from a point opposite origin of ventrals horizontally backward as far as the anal on each side, the median line of belly also blue-green; back of the origin of anal these stripes merge into a generally green area that covers belly and extends to the blue caudal peduncle; breast green, without distinct markings; back of body also more or less green throughout, nowhere yellow or brown like sides. Upper part of head and anterior portion of lower jaw blue-green; four yellowish stripes radiating from eye; opercle mostly dark violet brown, a blue scale over axil of pectoral, cheeks yellowish, snout and lower lip gray. Dorsal bright blue-green, a single whitish band along spinous part, on soft dorsal this splits into two, the two bands connecting again along the membrane between the last two rays; anal similar, though with but one basal band; caudal bright blue, more greenish toward center, spotted here and there with white; pectorals bluish green, their tips white; ventrals dull greenish, the first rays brighter. It seems likely that much of the area here described as whitish was originally of some shade of red.

PSEUDOSCARUS TROSCHELI (Bleeker).

This species, recorded by Steindachner from Laysan, is reported by Fowler from Honolulu.

PSEUDOSCARUS HELIOTROPINUS Bryan.

This species, known only from a single specimen and a painted cast in the Bishop Museum, is extremely close to the East Indian *P. xanthopleura* (Blecker), differing only in certain details of color.

Below I quote Bryan's original description of *Pseudoscarus heliotropinus* from the Director's report of the Bishop Museum for 1905 (p. 23, fig. 3). This paper, in which a number of Hawaiian *Scari* are described, three of them new, is little known.

Head 3.2 in body; depth 3.1; eye 8 in head; interorbital 2.6; D. IX, 9; A. II, 9; P. 14; scales 2–25–7.

Body very stout; head deeper than long; snout blunt, the dorsal outline strongly convex, the anterior profile rising almost vertically from the lips; teeth blue; upper jaw with one or two blunt canines; depth of caudal peduncle 2 in head; scales deeper than long; two rows of large scales on the cheek, one row on the subopercle; lateral line interrupted under the last dorsal ray, but continued on the second row below; pores with two or three irregular branches; anal and dorsal about equal in height; caudal deeply lunate, the outer rays extending beyond center rays twice the length of latter; ventral 1.8 in head, falling short of anal by 0.6 their length; pectoral broad, 1.2 in head.

Color in formalin + alcohol. General color, grayish brown; brownish over the snout; an indistinct greenish patch on the cheek and lower lip; ventral margined and tipped with greenish, remaining portion pale; dorsal with a greenish base and margin; caudal like the body, but with outer streamers and two or three ill-defined spots greenish; base and outer third of the anal greenish, portion between pale; pectoral pale, with an indication of green. Teeth blue.

Color (based on plaster cast colored from life). General color of lower half of body, pale salmon, varied with bluish scale markings; dorsal anterior half of body back to tip of pectoral heliotrope brown; remainder of dorsal portion as well as caudal peduncle pure green, varied with pinkish scale markings; interorbital region greenish brown; upper lip green, edged with orange-ochraceous; an ill-defined brown stripe over the middle of the snout; a broad orange-ochraceous patch on the lower lip, which is bordered above and below with blue, the latter color joining at the angle of the mouth, becoming a greenish blue patch on the cheek which is crescent-shaped on its posterior outline, one point of the crescent reaching to the eye; greenish stripes radiating from the eye, narrow greenish stripe connecting the points of the crescent on the cheek; scales on the cheek greenish; chin flesh color, with a few irregular blue spots; dorsal edged with blue; blue marks along the bases of the third to sixth spine; remaining rays with serrate green ray marks; remainder of the fin salmon color; anal broadly margined with blue; blue membrane spots at base, forming an irregular line; remaining portion salmon-pink; caudal with the outer rays blue passing into green, the green extending over most of the elongated rays; inner edge of the elongated rays and central portion of the tail ochraceous-salmon; four large irregular green blotches on the middle rays arranged so as to form a subterminal bar, with its posterior edge one-fourth of the length of the middle rays from the margin of the caudal; a few blue spots between the blotches and the base of caudal; ventrals salmon color, the outer ray for its entire length, the second for its distal half blue; pectoral green; iris yellow.

The type (B. P. B. Museum No. 3363) here described was secured in Honolulu market February 8, 1903, and measures 22 inches.

PSEUDOSCARUS XANTHOPLEURA Bleeker.

This East Indian species is reported by Fowler from Honolulu. Fowler regards it as distinct from *P. heliotropinus* Bryan, which it certainly resembles.

Family ECHENEIDAE

Genus REMOROPSIS Gill

REMOROPSIS BRACHYPTERA (Lowe).

Reported by Fowler.

Family GOBIIDAE

OPUA E. K. Jordan, new genus

(*Type.—Opua nephodes* E. K. Jordan.)

This genus, with *Mugilogobius* and *Vaimosa*, differs from other genera of *Gobiidae* in having scales on the upper part of the opercle, but none on the cheeks. From *Vaimosa* and *Mugilogobius* it is distinguished by the larger scales, which do not decrease in size anteriorly; by the larger teeth in several series, with two moderate canines in the middle of the side of the lower jaw, and by the shape of the head, the interorbital being much narrower and not flattened above. The dorsal spines are not prolonged into filaments as in *Mugilogobius*.

(*O'opu*—Hawaiian name for gobies.)

OPUA NEPHODES E. K. Jordan, new species.

Plate 2, fig. 2

Head 3.4 in length; depth 4.5; eye 3.2 in head; depth of caudal peduncle 3; snout 4; D. VI–10; A. 10; P. 18; scales in lateral series 26, in transverse series 9.

Body elongate, moderately compressed, evenly tapering from the greatest depth just behind the head to caudal peduncle; head not large, rather narrow, moderately pointed, not flattened above; interorbital space very narrow, slightly concave, its width about 5 in diameter of eye; eyes large, directed laterally and more or less upward, the lowermost point on orbit lying slightly above axis of body; snout blunt; mouth oblique, at a considerable angle, small, not quite reaching anterior edge of pupil; jaws equal; upper side of snout with a number of parabolic ridges parallel to each other and opening forward; cheeks and snout naked, without scales or prominent papillary ridges; lower part of opercle naked; upper third of opercle scaly, there being two rows of large ctenoid scales similar to those on body, 4 scales in lower row and 5 in upper, a few other very small ones above; preopercular margin entire, no spines anywhere on head; teeth in upper jaw conic, simple, in many series, 3

series more strongly developed than others, no true canines in upper jaw, though the outermost series approach canines in front; lower jaw with numerous series of strong backward curved, thin, hook-like teeth, the outermost series the strongest, 2 backward directed canines much larger than other teeth in the outermost series at each side of lower jaw, of these the posterior is the longer; no teeth on vomer; tongue bluntly rounded at tip; body covered with large, ctenoid, obscurely longitudinally striated scales, these about equal all over body, about as large anteriorly as posteriorly, the scales on back anterior to first dorsal are a little smaller, however; dorsal fins rather low, separate from each other, and from caudal, the middle spines of first dorsal not prolonged into filaments; anal similar to soft dorsal; pectoral moderately long, entire, the middle rays the longer; ventrals completely united, free from belly; caudal somewhat pointed, the middle rays longer than the outer.

Ground color yellowish white all over, much mottled, streaked, and clouded with olive brown; under a lens the dark markings appear as closely spaced groups of fine dots; a row of about five dark clouds down median line of each side; sides obscurely longitudinally striped with dark, about 6 such stripes, the belly pale, somewhat clouded, but without distinct markings; head rather dark, without distinct markings, the interorbital space and the top of snout dark; dorsal dark, obscurely longitudinally banded with lighter; anal nearly black, not banded; caudal with distinct light and dark cross bars; ventrals nearly black in male, dusky in female, not banded. The above description is from alcoholic specimens, but applies equally well to the color in life; in life the fish is perhaps a little darker in general appearance, but there is no color anywhere other than gray and olive brown.

Twelve specimens from 1 to 2 inches in length were taken in the Honolulu market. They were picked out of a pile of small brackish water gobies, and presumably came from one of the muddy brackish lagoons near Honolulu.

Type.—Cat. No. 87419, U.S.N.M.; paratypes are cat. no. 23612, in Stanford University Collection; paratypes are in Cornell University and in the University of Minnesota.

Genus GOBIOPTERUS Bleeker

GOBIOPTERUS FARCIMEN Jordan and Evermann.

A second specimen of this little rock goby is recorded by Fowler.

Genus CHLAMYDES Jenkins

CHLAMYDES LATICEPS Jenkins.

A second specimen of this little fish is recorded by Fowler from Laie, Oahu.

Family TRICHONOTIDAE

Genus CRYSTALLODYTES Fowler

CRYSTALLODYTES COOKEI Fowler.

A minute translucent fish burrowing in the sand, described by Fowler from Laie Beach, Oahu, where it was found by Charles Montague Cooke, III.

Family BLENNIIDAE

Genus CIRRIPECTES Swainson

CIRRIPECTES ALBOAPICALIS Ogilby.

Recorded by Fowler.

Genus SALARIAS Cuvier

SALARIAS MELEAGRIS Valenciennes.

Recorded by Fowler from Laie.

Genus ENCHELYURUS Peters

ENCHELYURUS EDMONDSONI Fowler.

A very minute fish found on the reef of Homonumi, Molokai, by William Alanson Bryan. From the equally minute *Enchelyurus ater* it is distinguished by varied coloration, as *ater* (=*brunneolus* Jenkins) is uniform black. These species, with *Eviota epiphanes* and *Enneapterygius atriceps*, all less than 2 inches in length, inhabit coral heads.

Family FIERASFERIDAE

Genus FIERASFER Cuvier

(*Carapus* Rafinesque in part.)

(The International Commission of Zoological Nomenclature has decided that the name *Carapus* is eligible for this genus in place of *Fierasfer*. It seems to me that in a case as doubtful as this we may well follow common usage.)

FIERASFER HOMEI (Richardson).

An additional specimen is recorded by Fowler.

Genus JORDANICUS Gilbert

JORDANICUS UMBRATILIS (Jordan and Evermann).

This species, mottled black in life and not translucent, is occasionally found in the body of a large black Holothurian. It is perhaps the species noted by Fowler as *Jordanicus gracilis* (Bleeker) from Kahala, Oahu. The two forms are regarded as identical by

Günther,[19] but *gracilis* is described as "yellowish, blackish posteriorly," which does not correspond to the dark coloration of *umbratilis*.

Family LOPHOTIDAE

Genus Lophotes Giorna

LOPHOTES CAPELLEI Schlegel.

Recorded by Fowler, from Laysan.

Family BALISTIDAE

Genus PARABALISTES Bleeker

Cheeks mostly naked; no spines on tail; ventral spine movable; dorsal and anal elevated; caudal lobes filamentous in the adult.

PARABALISTES FUSCUS Schneider.

Recorded by Fowler.

Genus CANTHIDERMIS Swainson

CANTHIDERMIS ANGULOSUS Quoy and Gaimard.

This rare species, figured by Jordan and Jordan, is probably the one recorded by Fowler as *Canthidermis maculatus* Bloch. The body is covered with round white spots.

CANTHIDERMIS ROTUNDATUS Procé.

Recorded by Fowler. This species, as described by Procé,[20] is said to be brown with black dots; D. III–26; A. 21. Scales tricuspid; equal; tail unarmed.

Family MONACANTHIDAE

Genus CANTHERINES Swainson

Pseudomonacanthus Bleeker, with pronounced barbs on the dorsal spine, can not be separated from *Cantherines*, in which the spine is simply rough; there is a perfect gradation between the two types.

CANTHERINES SANDWICHIENSIS Quoy and Gaimard.

A common species, the body color in life nearly uniform black, with orange dorsal and anal. The snout is hardly paler than the rest of body; caudal nearly black, not barred with lighter. Ventral flap not much enlarged; dorsal spine very long and slender, its length nearly equal to that of head, the surface of the spine not very rough. *C. pardalis* Rüppell of the East Indies may be distinct, but *C. carolae* Jordan and MacGregor, of the Revillagigedo Islands

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[19] Fische der Südsee, vol. 8, p. 339, 1909.

[20] Sur plusieurs espèces nouvelles de Poissons et de Crustacés observeés par M. Marion de Procé, Manila, 1822.

off the west coast of Mexico, seems to be the same. In *C. carolae* the dorsal spine is a little shorter than in *C. sandwichiensis.* The two species are considered identical by Jordan and Evermann, as by Jordan and Jordan.

CANTHERINES VERECUNDUS E. K. Jordan, new species.

Plate 2, fig. 3

Head 3 in length; depth 1 to 1.6; eye 3.6 in head; snout 1; interorbital 3; D. 1–34; A. 31; P. 13.

Body oblong, moderately elevated; snout long; mouth small; anterior profile gently concave, a little convex in front of eye; from dorsal spine to caudal peduncle the dorsal outline is a long, low curve; jaws with strong incisors, the lower included, the teeth white with golden brown tips; eyes high up, the interorbital elevated; gill slit oblique; ventral flap wide; body uniformly sandpapery; dorsal spine short, stout, straight, distinctly rough but without true superimposed hooks or spines, its length about 1.8 to 1.9 in head; dorsal groove short, shallow posteriorly, reaching only about two-thirds of the distance back from base of dorsal spine to origin of soft dorsal; distance between origin of soft dorsal and dorsal spine slightly greater than from snout to eye; dorsal relatively low; its rays from about fourth to eighth somewhat elevated, their length about half head; anal similar to soft dorsal; caudal truncate, slightly convex; pectoral short, its length 2.5 in head; pelvic spine stiff, not movable, projecting little beyond the broad ventral flap.

Color in life dull olive brown, usually with about 4 obscure darker saddles crossing belly between pelvic spine and snout; 2 similar saddles crossing forehead, 1 just in front of eye, and 1 just above snout, this obscurely connected around snout to the dark patch below, 2 similar saddles on back between dorsal spine and origin of soft dorsal, about 3 more crossing back and belly beneath soft dorsal and anal, respectively; 2 narrow bands on top and bottom of caudal peduncle, none of these bands or saddles connecting across sides of body except just behind snout; sides of body mottled, blotched, and clouded with lighter and darker, never uniform but with no distinct or constant markings whatever; lips abruptly pale; vertical fins dusky brownish, the rays darker, the membranes pale, no red, orange, or clear yellow anywhere; caudal distinctly vertically barred; pale at base, then nearly black, then pale, then broadly black to tip, 2 light and 2 dark bars in all. Some specimens are almost plain dark olive brown, the figure here presented being taken from one of these. One example shows a row of round white spots along base of anal.

Color in spirits not materially changed, the cloudings slightly fading.

Seven specimens taken in the Honolulu market, all from 4 to 5½ inches in length; two others in Stanford University (Cat. No. 8465) collected by E. L. Berndt in Honolulu.

Type.—Cat. No. 87420, U.S.N.M. cotypes are Cat. No. 23373 in the Stanford University collection; a paratype is at Cornell University.

This species is related to *Cantherines sandwichiensis* (Quoy and Gaimard) the common species about Hawaii, but it differs markedly in color, being a dull olive, mottled and clouded, but without black or white spots; the fins are a paler olive. In *C. sandwichiensis* the body is uniform plain brownish black, not clouded with darker, usually with small round black spots more or less numerous on head and anterior parts. The dorsal and anal fins in *C. sandwichiensis* are higher than in *C. verecundus* and bright orange red in life and the caudal plain blackish. In *C. verecundus* the caudal has two diffuse crossbars of blackish with paler interspaces and the dorsal and anal are plain dusky brown, without red or orange. The dorsal spine in *C. verecundus* is shorter, stouter, and rougher, and the ventral flap (more or less) deeper than in the other, this feature being subject to some variation.

The third species of *Cantherines* recorded from Hawaii, *C. albomaculatus* Seale (*C punctulatus* Regan) has the body marked with profuse white spots. *C. armatus* Garman from Fiji has more than 40 dorsal and anal rays. *C. nigricans* Macleay from New Guinea has the rays, D. 26, A. 23. *C. fuliginosus* Macleay also from New Guinea, with long dorsal spine is apparently quite distinct.

(*Verecundus*, modest.)

Genus MONACANTHUS Cuvier

MONACANTHUS SPILOSOMUS Lay and Bennett.

The genus *Stephanolepis*, distinguished from *Monacanthus* by the narrowness of the ventral flap, can hardly be maintained as the character is subject to intergradations.

Family TETRAODONTIDAE

Genus LAGOCEPHALUS Swainson

LAGOCEPHALUS OCEANICUS Jordan and Evermann.

In a cast in the Bishop Museum, the back is nearly black, the sides abruptly silvery, but with no trace of the round black spots seen in the original types. This species stands at the extreme of a series, which in Japan shades off by degrees into the genus *Sphoeroides* Lacépède. *Sphoeroides* is the original form of this word first used in an unsigned review of Lacépède 1798. *Spheroides* dates from 1806.

TETRAODON HISPIDUS Linnaeus.

This fish is very common at Honolulu and its flesh has the reputation of being highly poisonous, producing the dreaded disorder known in Cuba as Ciguatera. It is, however, brought into the markets, where it is skinned and the viscera removed, the flesh itself being regarded as innocuous. Fishermen say that the poison is in the gall bladder. The pathology of Ciguatera is much in need of study.

This fish is generally known as *Tetraodon hispidus* though it may not be the same as the original *hispidus* of Linnaeus. This is based on a specimen brought by Magnus Lagerström from China.

Dr. Einar Lonnberg, who has examined this type,[21] says of it: "The type of *Tetraodon hispidus* Linnaeus is probably the same species as *T. hispidus* of other authors, but it can not be proved certain without comparison with other types. The spines of the belly are rather long and like bristles. The specimen is discolored." In view of this statement it is doubtless safest to retain the same *hispidus*, rather than exchange one doubtful opinion for another. The next name in point of time after *hispidus* is apparently *Tetraodon perspicillaris* Rüppell, from the Red Sea, which agrees fairly with Hawaiian examples. *Ovoides erethizon* Jordan and Gilbert from Panama is certainly the Hawaiian fish.

This species is not *T. implutus* Jenyns, nor *T. laterna* Richardson. Bleeker regards these as identical but figures the species as having the pale spots ringed with black, which is not the case with the Hawaiian form.

The stripes on the belly in *T. hispidus*, black anteriorly, yellow farther back, vary much with age, often fading as the fish grows older.

There is some variation in the coloration of this fish in Hawaiian waters, some individuals having few large round white spots on a dark background to others with the back covered with many smaller, pearly bluish spots. These forms can not be farther separated, but no examples from Hawaii are without white spots.

Genus LIOSACCUS Günther

LIOSACCUS CUTANEUS Günther.

Recorded by Fowler.

Genus CANTHIGASTER Swainson

CANTHIGASTER MARGARITATUS (Günther).

Recorded by Fowler.

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[21] Kong. Svensk Vet.-Akad., Handl., vol. 2, pp. 22, 30.

Family OSTRACIIDAE

Genus OSTRACION Günther

OSTRACION CUBICUS Linnaeus.

Recorded by Fowler.

Genus LACTORIA Jordan and Fowler

LACTORIA GALEODON (Jenkins).

Two rather small specimens, though larger than the original types, about 3 inches in length, were obtained in the Honolulu market. This species is apparently wholly distinct from *L. diaphana* of Japan.

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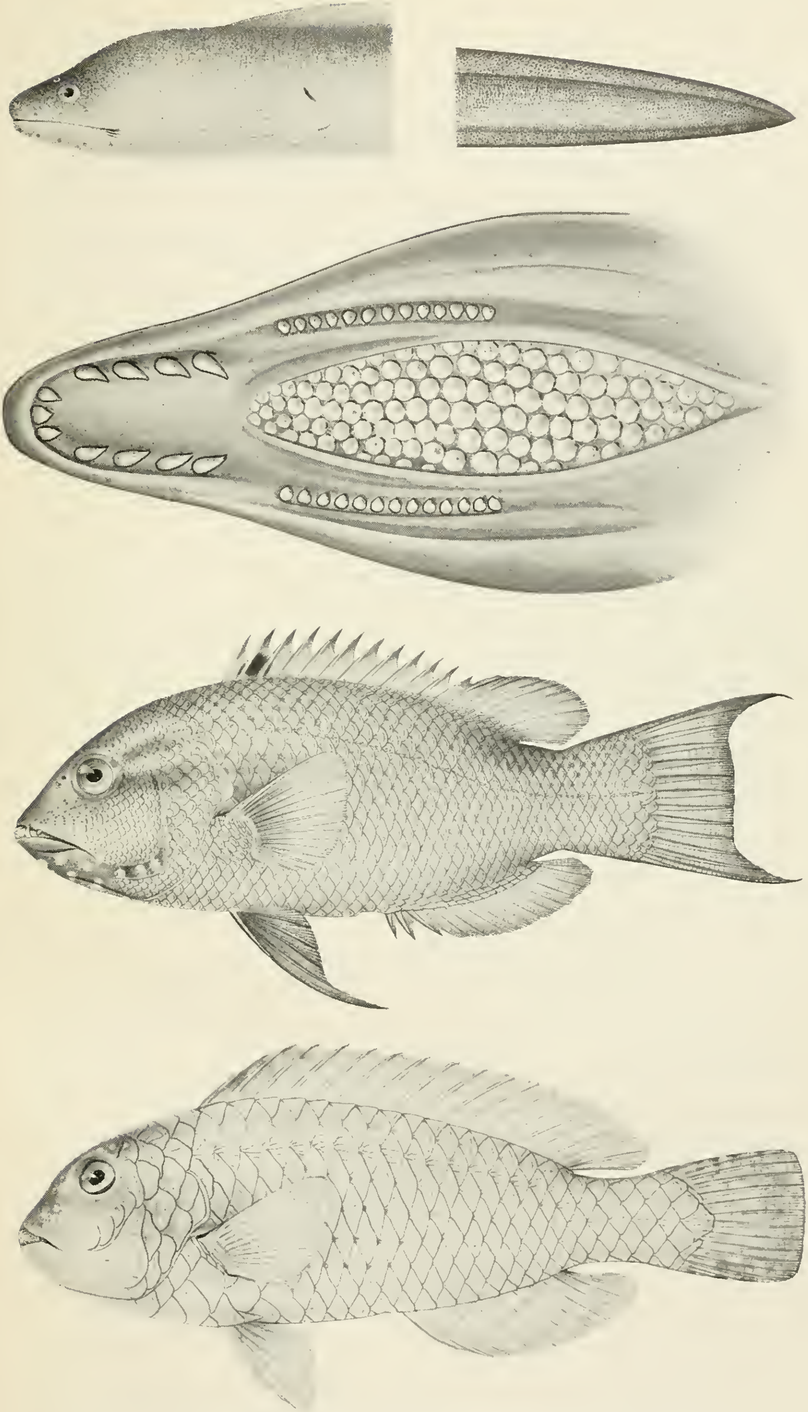
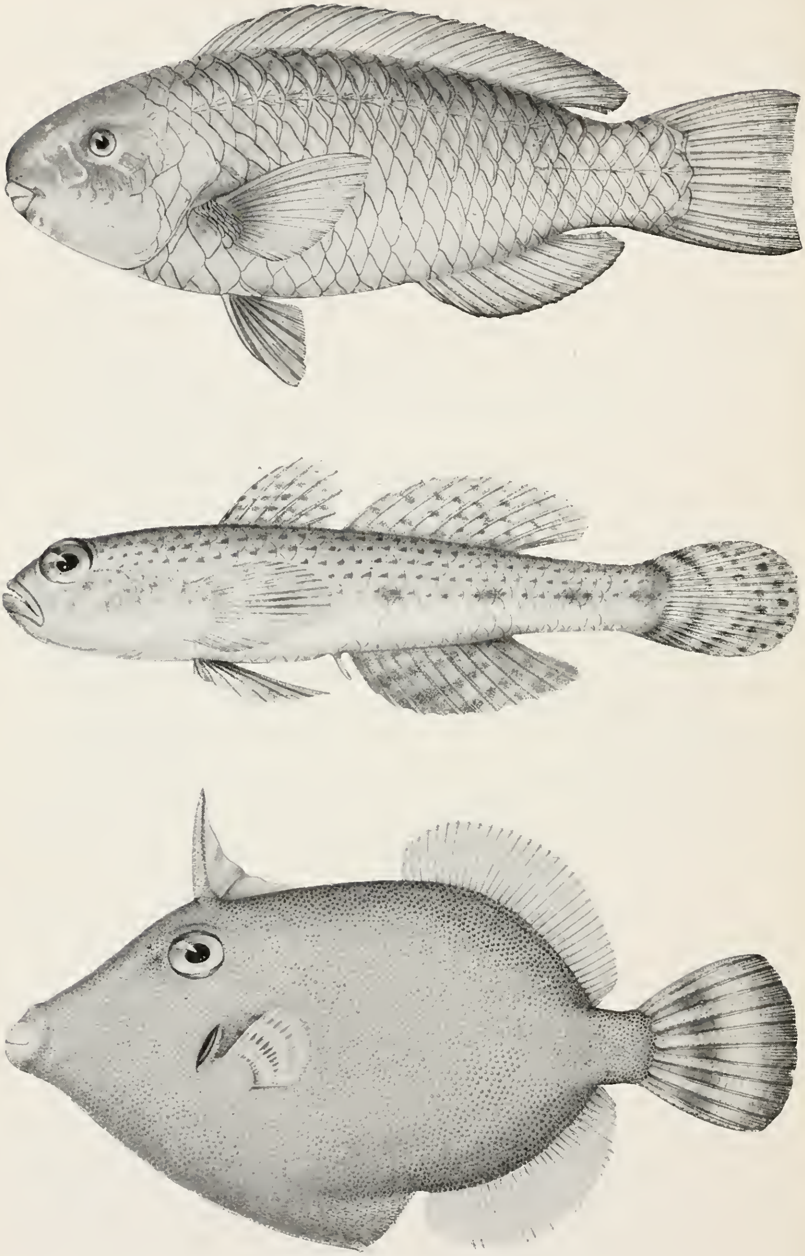


Leihala tritor (Page 5); Upper Teeth of Same (Page 5); Lepidaplois atrorubens (Page 23); Scaridea farrandi (Page 28)



SCARUS KRAUSSI (PAGE 30); OPUA NEPHODES (PAGE 36); CANTHERINES VERECUNDA (PAGE 40)

A FURTHER AND DETAILED DESCRIPTION OF THE TYPE OF ELEPHAS ROOSEVELTI HAY AND DESCRIPTIONS OF THREE REFERRED SPECIMENS

By Oliver P. Hay

Associate of the Carnegie Institution of Washington

1. DESCRIPTION OF THE TYPE SPECIMENS

In 1922[1] the writer characterized briefly a species of elephant to which he applied the name *Elephas roosevelti.* As the type of this species were taken the right upper and lower hindmost molars of an elephant found in 1901 at Ashland, Cass County, Illinois, and now in the United States National Museum. The catalogue number is 2195. In 1923[2] these teeth were mentioned under the name *Elephas primigenius*, for the reason that Publication 322 was already in press when the name *E. roosevelti* was proposed.

The teeth are well preserved, but not without deficiencies. They had not been long in use, being worn back to about the twelfth ridge-plate, but not to the base in front. The upper tooth (pl. 1) lacks probably two or three of the hindmost plates. The lower tooth (pls. 2, 3) has lost apparently two or three front plates and one or two hinder ones. Both teeth are yet mostly covered with a layer of cement. The roots consisted of only a thin layer of dentine over the large pulp and were destroyed in exhumation of the specimen. The front roots of the upper tooth appear to have supported 3 ridge-plates. In the lower tooth one plate remains of those supported by the front root.

The extreme diagonal length of the upper tooth in its present state is 305 mm.; the length along the base on the outer face is 275 mm.; originally it was not far from 290 mm. The height between the first and second thirds of the length, taken at right angles with the base, is 172 mm. The thickness at the same place is 90 mm. The inner face of the tooth is convex in the front half, concave in the hinder half. The outer face is convex. There are present 23

[1] Proc. Biol. Soc. Washington, vol. 35, p. 100.
[2] Pub. 322, Carnegie Inst. Wash., p. 141.

12052—25

ridgeplates; originally there were probably 25. Measured on the outer convex face the tooth presents 8 plates in a 100 mm. line; on the inner, concave, face there are 9. The enamel, as shown on the abraded surface, is thin, delicate, and little folded. Its thickness rarely exceeds one millimeter. The thickness of the cement plates and that of the dentine plates enclosed by the enamel are, on an average, equal.

A part of the upper right second molar (pl. 3, fig. 4) was yet in use. During or after exhumation most of the outer half was lost. It had been worn so that in front there remained only dentine and behind this the bases of six or seven enamel plates. The part preserved is 98 mm. long and 78 mm. wide. The plates are divided at the midline into an inner and an outer series of loops of enamel and these loops are directed obliquely backward from the midline. Wear had reached the level where the enamel of each ridgeplate turns toward that of the adjacent plate and joins it. The loops therefore enclose, not dentine, but cement. On the left side (right side in the figure) there is a continuous band of enamel from the first plate to the last one. The rear of this second molar fits quite accurately against the front of the third molar. The two teeth together had 18 ridgeplates in action.

The lower right third molar (pl. 2; pl. 3, fig. 1) presents 23 ridgeplates; there were originally 25, perhaps one or two more. The occlusal border of the tooth is concave from the rear forward. Where the ridgeplates are worn down, there was doubtless originally a rounded boss. The base of the tooth is convex, but would have been less so when the rear plates had reached their full length. On the outer concave face are 8 ridgeplates in a 100 mm. line; on the convex face only 7. The hindmost plates are a little thicker than those in front. The length of this tooth in its present condition, measured from the middle of the summit of the ridgeplate in front to the middle of the base of the hindmost, is 295 mm. The greatest length was originally near 325 mm. The height at the hindmost worn plate is 152 mm. The thickness is 90 mm.

A fragment of the lower second molar appears to belong on the right side and has a surface for contact with the next molar behind; but this third molar has lost the front plate and therefore the contact surface. The loops of enamel of the second molar are divided into two rows, as in the upper second molar, and the loops enclose the cement. Only 4 ridgeplates are represented in this fragment.

The symphysis of the lower jaw is present and about 200 mm. of the right ramus. The beak is moderately prominent. A little to one side of the symphysis the height of the jaw is 120 mm. There is present a fragment of the tusk about 400 mm. long and about 150 mm. in diameter.

The remains above described appear to have been buried in the loess which covers the Illinoian drift around Ashland. Apparently the animal lived during the late Iowan stage or the early Peorian.

2. A PALATE OF ELEPHAS ROOSEVELTI FOUND IN WISCONSIN

On plate 4 are presented two views of a palate of an elephant which was found in Milwaukee and is preserved in the public museum of that city. Figure 1 was originally published and the specimen described by the writer in 1914.[3] The specimen was there referred to *Elephas primigenius*, but it is now regarded as belonging to *E. roosevelti*. The specimen presents the second and third upper molars of both sides and a part of each maxillary bone that runs upward and forward from the second molar.

Through the director, Dr. S. A. Barrett, and Prof. Ira Edwards, curator of geology in the public museum, the writer has received a photograph showing the palate as seen at right angles with the grinding surfaces of the second molars (pl. 4, fig. 1). Of these molars there remain only the hinder half of the crown and the great hinder root. The length of the grinding surface is 175 mm. In front the teeth are worn down to the common base of dentine. In one tooth there remain 12, in the other 13 ridgeplates. The front 2 or 3 loops of enamel inclose cement instead of dentine. It will be noted (pl. 4, fig. 2) that the grinding surfaces of these teeth make little more than a right angle with the lower border of the hinder tooth; also only slightly more than a right angle with the sheath of the tusks. These features appear to indicate a shortened skull. The hindmost molar was just coming into use and no roots had yet been developed; probably about 4 plates were lost from the hinder end in exhuming the specimen. Originally the greatest diagonal measurement must have been close to 375 mm. There are 8 enamel plates in a 100 mm. line. This elephant died after the last ice sheet had withdrawn beyond Milwaukee, but it is probably to be credited to the Wisconsin glacial stage.

3. A MOLAR OF ELEPHAS ROOSEVELTI FOUND IN OHIO

In the U. S. National Museum is an upper left hindmost molar (catalogue number 4761) found in Ohio and referred to *Elephas roosevelti*. The locality is in the northeast corner of Wayne Township, Darke County. The tooth is apparently the one mentioned by A. C. Lindemuth in 1878.[4] It had been found in a creek just north of Versailles. A record of it as *Elephas primigenius* is in the writer's Pleistocene of North America east of the Mississippi, etc. (1923, p.

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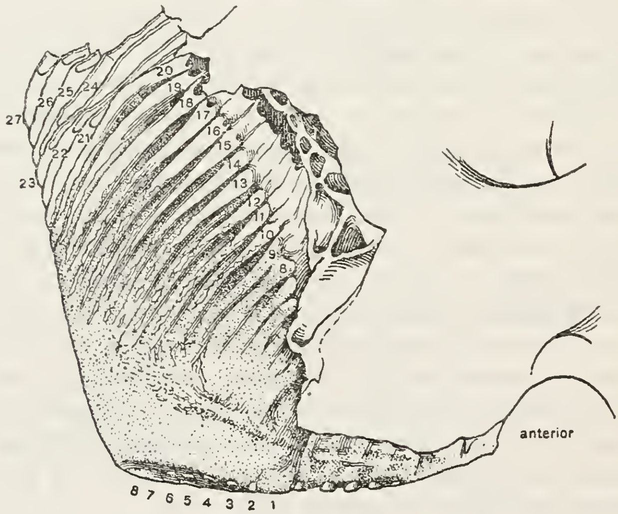
[3] Iowa Geol. Surv., vol. 23, p. 409, pl. 59.

[4] Geol. Surv. Ohio, vol. 3, pt. 1, p. 509.

136). Darke County is covered with Wisconsin drift. The animal lived, therefore, after the last ice sheet had withdrawn from the locality. The tooth lacks little of being as complete as it was at the death of the animal. Apparently one ridge-plate, possibly two, are missing in front, and one or two are gone from the rear. Twenty-one and a half are present. Nine are crossed by a 100 mm. line. The enamel is thin. The pulp cavity was large and the transverse ridges formed by the meeting of the enamel of two contiguous ridge-plates are in view. The original length of the base was close to 260 mm. The height near the front and perpendicular to the base is 154 mm. The greatest thickness is 103 mm.

4. TEETH OF ELEPHAS ROOSEVELTI FOUND IN INDIANA

Prof. H. F. Osborn[5] described and figured teeth of an elephant found in Indiana which he referred to *Elephas primigenius*. His figure is here reproduced. Calculated from the figure, the length of the



TOOTH AND PART OF THE SKULL REFERRED BY OSBORN TO ELEPHAS PRIMIGENIUS. × .25

hindmost molar from the base in front to the middle of the hinder plate is about 255 mm.; the height at the middle of the length close to 120 mm.: the width of the grinding surface only about 65 mm. It is thus very narrow, but doubtless on further wear it would increase in width. Osborn states that 13 ridge-plates are compressed into 100 mm. space. There is an error somewhere. The writer estimates that there are only 10 plates in 100 mm. Indeed, on an average, there appear to be only 9 in this distance. In this Indiana specimen, after it was worn on 8 plates, the unworn grinding border

[5] Amer. Mus. Novitates, No. 41, p. 8, fig. 8,

is still at right angles with the grinding surface of the second molar.

After this paper was put into type Prof. H. F. Osborn redescribed his specimen under the name *Mammonteus primigenius compressus* (Amer. Mus. Novitates, No. 152, December 20, 1924). The present writer believes that the remains belong to *Elephas roosevelti*. The rear of the tooth has the appearance of being restored by the artist.

Elephas roosevelti is most closely related to *Elephas boreus*, as is shown by the number of plates in the hinder molars, their thickness, and the thinness and simplicity of the enamel. The species appears to differ from *E. boreus* in the approximate parallelism of the upper and lower borders of the hinder upper molars and their perpendicular position as they begin to function. This position is quite different from that of the hinder molars of the Indian and the African elephants at the same stage. It is to be hoped that the early discovery of a complete skull of *Elephas roosevelti* will add to our knowledge of the species.

EXPLANATION OF PLATES

Plate 1

Elephas roosevelti Hay. Right upper third molar seen from right side. Type. ×.465.

Plate 2

Elephas roosevelti. Right lower third molar seen from right side. Type. ×.487.

Plate 3

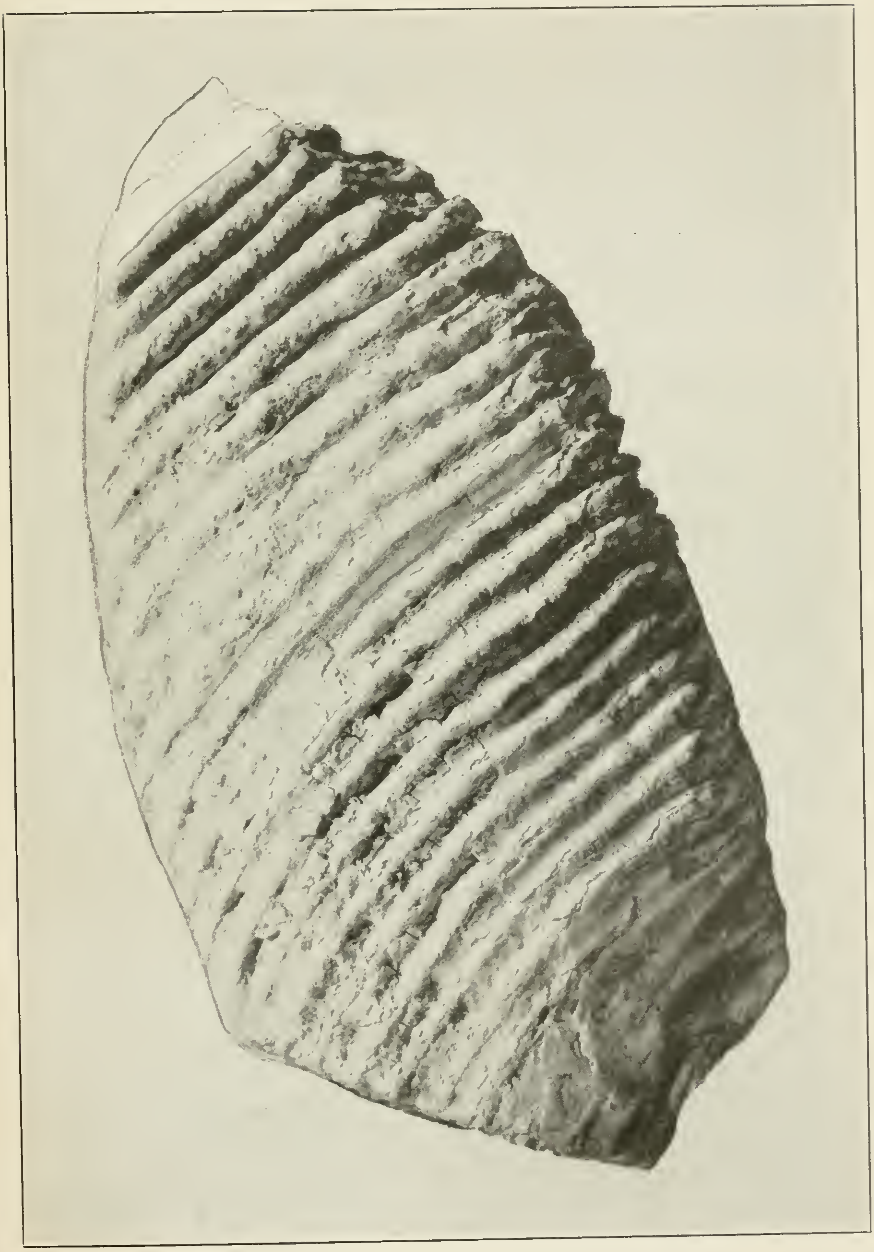
Elephas roosevelti.

Fig. 1. Lower right third molar. Type. ×.487.
2. Three ridgeplates of right upper third molar. ×.1.
3. Four ridgeplates of right upper molar. Slightly farther back than those of fig. 2. ×1.
4. Upper right second molar. Much worn. ×.51.

Plate 4

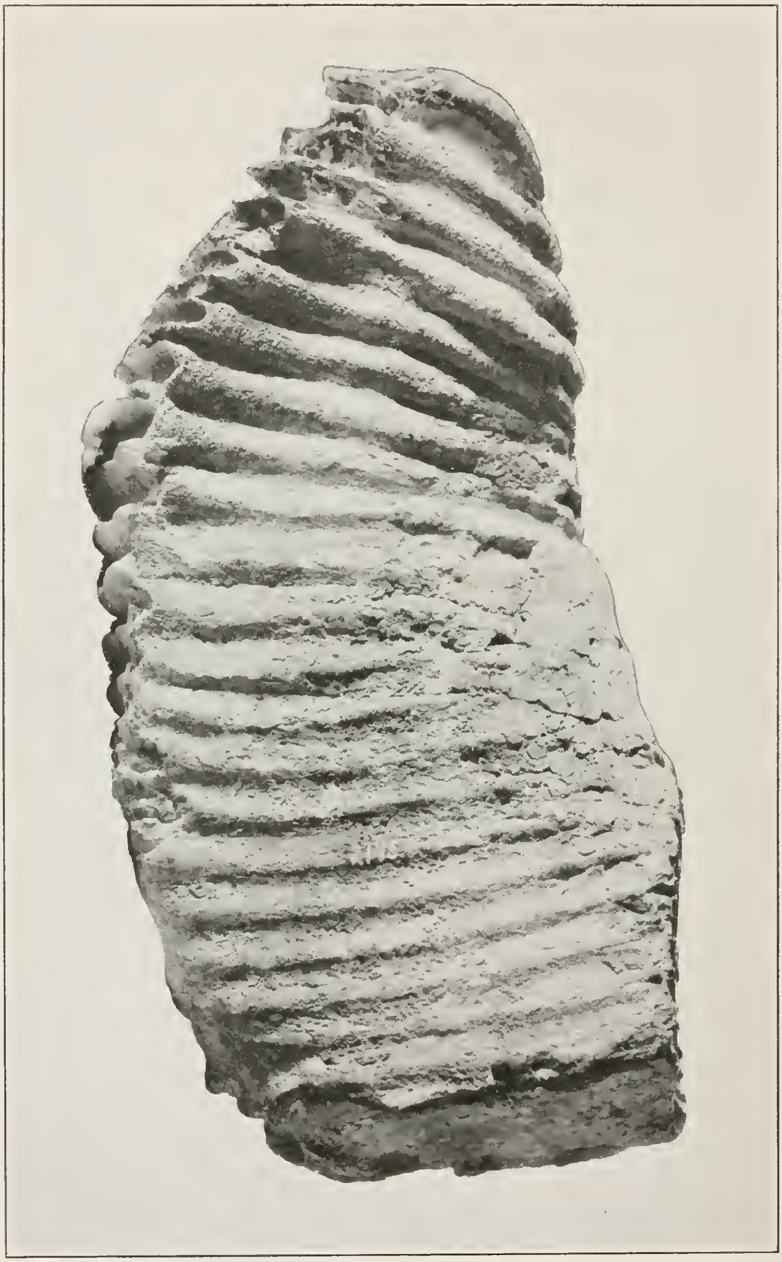
Elephas roosevelti. Upper teeth and palate of specimen in Public Museum, Milwaukee, Wis.

Fig. 1. Palate and upper second molars seen from below. Front end of teeth directed downward. ×.2.
2. Same specimen as that of fig. 1. Viewed from right side and showing second and third upper molars. On the right side is a part of the sheath of the tusk. ×.36.



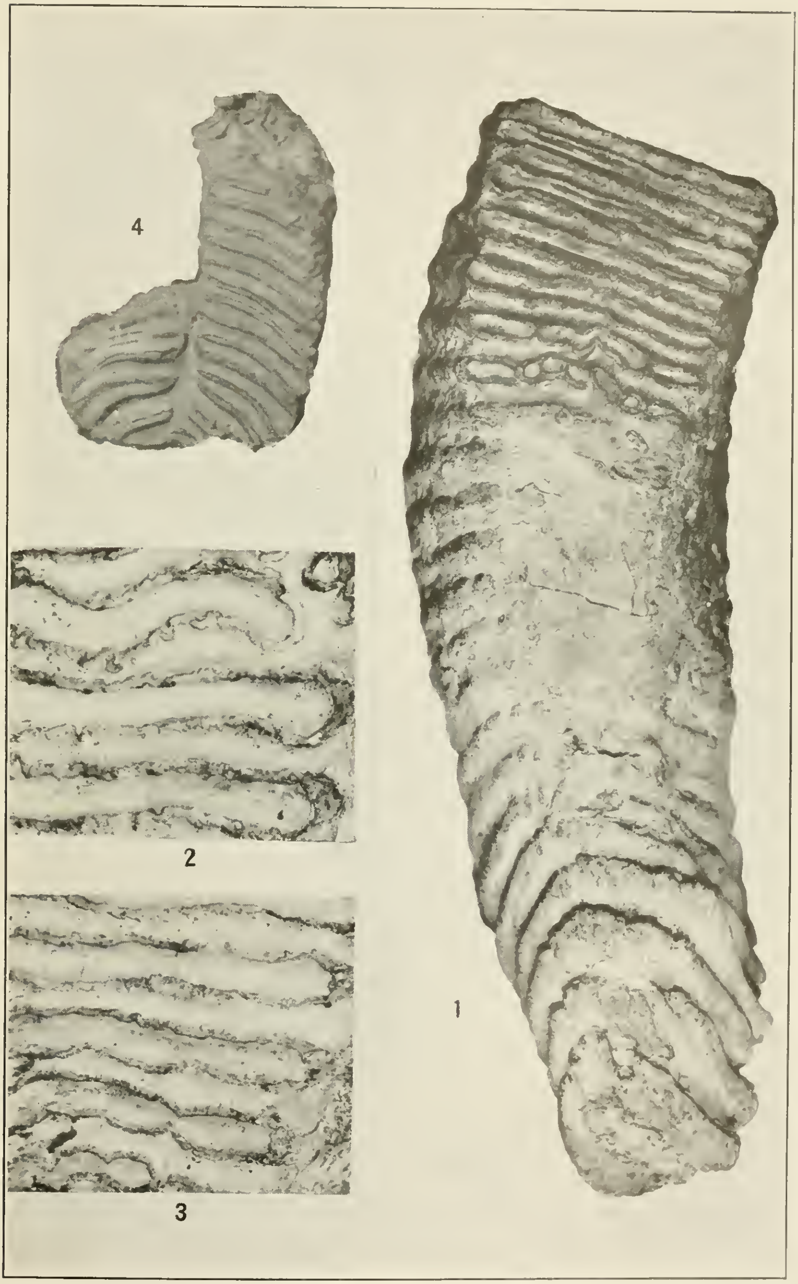
Right Upper Third Molar of Elephas roosevelti

For explanation of plate see page 6



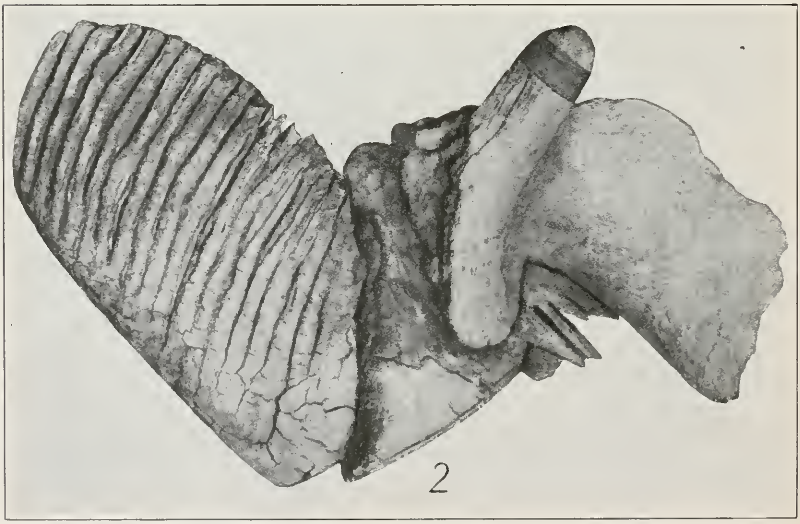
RIGHT LOWER THIRD MOLAR OF ELEPHAS ROOSEVELTI

FOR EXPLANATION OF PLATE SEE PAGE 6



Molars of Elephas roosevelti

For explanation of plate see page 6



UPPER TEETH AND PALATE OF ELEPHAS ROOSEVELTI

FOR EXPLANATION OF PLATE SEE PAGE 6

ON REMAINS OF MASTODONS FOUND IN TEXAS, ANANCUS BRAZOSIUS AND GOMPHOTHERIUM CIMARRONIS

By Oliver P. Hay

Associate of the Carnegie Institution of Washington

In the course of his paleontological work the writer has had the opportunity to study many interesting remains of mastodons found in Texas. It is proposed in this paper to describe those of two species.

A. ON ADDITIONAL SPECIMENS OF *ANANCUS BRAZOSIUS* HAY

1. On a large molar found in Texas and now in the British Museum

In 1886 Lydekker[1] under *Mastodon cordillerum*, recorded a third molar, said to be an upper, which had been found at an unknown locality in Texas, at some time before 1869. In the United States National Museum is a well-made cast of this tooth which was prepared at the British Museum of Natural History. This cast shows distinctly that the first crest of the crown is supported by a single fang, which extends wholly across the tooth. In an upper tooth there would be present two fangs, the inner of which would support likewise the inner end of the second crest. It must be concluded, therefore, that the tooth in question is the lower right third molar. From the British Museum of Natural History the writer has received photographs of this tooth and these are here reproduced (pls. 1, 2).

The molar is in a fine stage of growth and in a good state of preservation. Wear due to mastication had attacked only slightly the first and second crests. Apparently some of the enamel is missing from the outer face of the hinder talon. The length of the crown is 225 mm.; the width of the second crest is 90 mm. The cones of the outer ends of the crests possess buttresses which, when meeting those of columns in front and behind, block the valleys. At an early stage of wear the cones and their buttresses would present distinct trefoils, as is shown on the first crest. The inner ends of the valleys are open and the inner cones of the first,

[1] Cat. Foss. Mamm. Brit. Mus., pt. 4, p. 46.

second, and third crests are furnished with buttresses, narrow front and aft, which do not meet to close the valleys, but which, at a medium stage of wear, would produce trefoils. The basal lobes of these would naturally be smaller than those of the outer trefoils.

In the United States National Museum is also a cast, the gift of the British Museum of Natural History, of the left ramus of the lower jaw figured in Falconer and Cautley's Fauna Antiqua Sivalensis (on pl. 35, figs. 3 and 3*a*). This jaw was obtained in the Pleistocene of Buenos Aires, and on the plate cited was referred to as *Mastodon andium;* but in 1886 it was identified by Lydekker[2] as *M. humboldtii.* This species has been supposed to be distinguished from *M. andium* by the presence of trefoils on both ends of the crests, but the character is now recognized as variable. The buttresses of the inner ends of the crests of the Texas specimen are more prominent than those of the jaw from Buenos Aires. The writer does not see, therefore, why the Texas molar should not be referred rather to *M. humboldtii* than to *M. cordillerum.* The latter name is that employed by Lydekker for the mastodon called by other authors *M. andium* or *M. cordillerarum.*

2. ON A LOWER JAW FOUND AT CAMERON, TEXAS

From Dr. Mark Francis, of the Texas Mechanical and Agricultural College, College Station, Texas, the writer received in August, 1923, for examination, the horizontal portion of the left ramus of a lower jaw of a mastodon whose teeth present trefoils. This jaw was found in 1897, in a gravel pit near Cameron. From Judge Jeff T. Kemp, of Cameron, it is learned that the gravel pit was about 2 miles north of Cameron, at a height of between 40 and 50 feet above high water in Little River. The bone of this jaw extends from the symphysis to a short distance behind the third molar. The symphyseal region is injured and somewhat waterworn. The bone on the inner face was broken away so that the hinder root of the great molar was exposed. An additional part was lifted by the writer, in order to expose the other fangs (pl. 2, fig. 2; pl. 3, fig. 1). As to the dimensions of the jaw, the distance from the hinder end of the last molar to the hinder end of the symphysis was close to 235 mm. The depth of the ramus at the middle of the last molar is 160 mm.; the thickness, 138 mm.; the height at the front of the socket for the second molar is 190 mm.

In this mandible is present the socket for the second molar. This molar may have fallen out just before the death of the animal or afterwards. The cavity for its anterior fang is 50 mm. or more deep. The hinder fang must have been mostly absorbed. From the

[2] Cat. Foss. Mamm. Brit. Mus., pt. 4, p. 42.

front of the anterior socket to the front of the third molar is 10C mm. The tooth itself was probably several millimeters longer thar this.

The hindmost molar is much injured. The rear is badly shattered, so that most of the enamel of the fourth crest and of the talon is missing. The enamel of the inner ends of the three front crests is broken away. Notwithstanding the injuries, the structure of the tooth is well shown on the anterior crests. The first crest is worn down in front nearly to the base, and the part of the fourth crest remaining is well worn. When the second molar was yet in its place both it and nearly the whole of the third molar were in action. The length of the last molar is, allowance being made for the enamel missing in front, 225 mm.; the width at the second crest, 89 mm. The anterior crest presents a single lake of dentine and this opens into another surrounded by the enamel of the outer end of the second crest. The outer ends of the three front crests and the remaining part of the fourth display large trefoils. The enamel is about 7 mm. thick and is much folded, especially at the base of the trefoils. The inner ends of the crests present only a part of each figure produced by wear. It will be seen from the illustration (pl. 3, fig. 1) that trefoils with small basal lobes are developed.

It appears well to describe briefly the roots of this third molar: In front, supporting the first crest, is one great fang, 70 mm. wide near the crown and 179 mm. long, extending downward and backward to opposite the middle of the length of the crown. Behind this is a fang bearing the inner end of the second crest. The remainder of the crown rests on the great hinder fang, 100 mm. long, 100 mm. fore and aft near the crown, and 70 mm. at the distal end. The tips of these fangs rest on the bone roofing the inferior dental canal. It can hardly be that such powerful roots are required to hold the tooth in its place. Their great extent and the direction taken suggest that their purpose is to distribute over a great surface the pressure brought to bear on the crown during mastication.

On comparing the hindmost molar of this Cameron specimen with that in the British Museum, one can hardly escape the conclusion that they belong to the same species.

3. On an upper molar found near Waco, Texas

In 1917 [3] the writer provisionally referred an upper right second molar, found near Waco, to the then newly described species *Gomphotherium elegans* (now recognized as *Anancus mirificus*). This second molar is now believed to belong to *Anancus brazosius*. A remarkable character of this tooth is the large hinder talon forming a kind of half crest.

[3] Proc. U. S. Nat. Mus., vol. 53, p. 221, pl. 26, fig. 3.

4. On the relation of the Texan mastodon to the South American species

Boule and Thevenin[4] have shown how difficult it is in many cases to identify isolated teeth of the two recognized species of South American mastodons. They have demonstrated, furthermore, that the skulls and the tusks of the two species are wholly different. Now, in the case of the animal which bore such teeth as those represented by the Cameron specimen and the one in the British Museum, we know nothing about the skull or even the tusks. However much the teeth may resemble those of *M. humboldtii* or *M. cordillerum*, the upper tusks may have been straight or curved or twisted, or spiral, with or without an enamel band. The skull may have been in a stage of development like that of *M. andium* or in one like that of *M. humboldtii;* or it may have been in an intermediate stage.

Furthermore, it is uncertain that there is a single species of North American fossil vertebrate which is identical with a South American form. There is finally another reason why the Texas mastodon should not be referred to either of the species belonging in South America. This is found in the greater height of the crowns of the teeth. The height of the outer column of the third crest of the British Museum specimen, measured from the lower edge of the enamel to the summit, is 93 mm. The height of the corresponding column of the tooth in the lower jaw No. 19951 of the British Museum as represented by the cast mentioned above, is only 76 mm.

In the United States National Museum is the cast of another tooth belonging to the British Museum and recorded by Lydekker[5] by the number 19952*e*, and referred to *M. humboldtii.* This tooth is the lower right third molar and is 200 mm. long. In this, due allowance being made for the slight wear, the height of the column measured in the other specimens is little more if any than 60 mm. It appears evident, therefore, that the Texas tooth is more hypsodont than those of the South American species.

5. On the status of the generic name Anancus

For certain species of mastodons, including the one described above, the writer employs the generic name *Anancus.* This was first used for mastodon remains by Aymard in 1854,[6] when he announced a supposed new species *Anancus macroplus;* but he gave no description of either the genus or the species. Falconer[7] cited page 276 of the *Congrès Scientifique de France*, 1855, for the name.

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[4] Mammifères foss. de Tarija, 1920, pp. 44, 63, 64.
[5] Cat. Foss. Mamm. Brit. Mus., pt. 4, p. 44.
[6] Ann. Soc. Agric. Sci. le Puy, p. 597.
[7] Palaeont. Memoirs, vol. 2, p. 20, footnote.

There appears to be no copy of this work in America and the librarian of the British Museum of Natural History informed the writer that the name does not appear on that page, but that it occurs on pages 241 and 271. Having received from the British Museum photostats of those pages, I find that no description of either the genus or the species was given by Aymard in this paper. His name is therefore a *nomen nudum*.

In 1859, Lartet[8] quoted *Anancus macroplus* as a synonym of *Mastodon arvernensis*. This gave *Anancus* a nomenclatural standing; so that those who, like the writer, regard *Mastodon arvernensis* as belonging to a genus distinct from *Mammut* and from *Gomphotherium*, must accept the name *Anancus* Lartet. The writer, for the present, at least, regards the mastodon remains described above as belonging to the same genus.

6. On the specific names of the Texan specimens above described and of the two South American species

In 1923[9] the writer described a species of mastodon under the name *Anancus brazosius*, based on a right side of a mandible containing the second and third molars. These teeth present trefoils on the inner columns of the crests, but with the basal lobes smaller than those of the outer columns. The hindermost molar has five crests; but, as is usual, the fifth is relatively small. In the British Museum specimen referred by Lydekker to *M. cordillerum* the talon is so large as to simulate a crest (pl. 1). In the Cameron specimen the fifth division of the crown was large, but its structure is unknown. For the present the writer refers to *Anancus brazosius* the Cameron specimen, the molar from Waco, and the Texas tooth assigned by Lydekker to *M. cordillerum.*

In the preceding discussion the writer has employed for one of the South American species the names *Mastodon andium*, *M. cordillerarum*, and *M. cordillerum.* As pointed out in the writer's paper just cited, Fischer de Waldheim's name *Mastotherium hyodon* antedates all three of those mentioned. The species dealt with in the present paper will bear therefore the names *Anancus humboldtii*, *A. hyodon*, and *A. brazosius.*

B. DESCRIPTION OF REMAINS OF *GOMPHOTHERIUM CIMARRONIS* (Cope)

1. History of the specimens

From Dr. Mark Francis, of College Station, Texas, the writer has received for examination a collection of mastodon teeth and tusks which had been made in 1915, on the farm of Ed. Noble, about 5

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[8] Bull. Soc. Geol. France, ser. 2, vol. 16, p. 493.
[9] Pan-Amer. Geologist, vol. 39, p. 112, pl. 8, figs. 1, 2.

miles southeast of Navasota and half a mile south of Woods, Grimes County, Texas. The remains had already been removed from the ground when Doctor Francis learned of them. As is natural, when persons undertake to collect such fossils without instructions or previous experience, the remains suffered from the extraction. The collection consists of teeth in good condition (except the loss of the roots), portions of several upper tusks, a part of a lower tusk in a fragment of a jaw, and parts of two tusks of a young mastodon. From this same locality were collected some of the fossils which the writer described in January, 1924,[10] besides other species, not yet determined. Rhinoceros bones are not uncommon. The remains occur in the Fleming formation; and the writer concluded that this belongs in the Upper Miocene. Doctor Francis deserves commendation for having rescued such precious materials.

2. Description of the premolar teeth

What the writer takes to be the lower right and left third premolars are in the collection, and they are in a fine state of preservation. It is doubtful if they were erupted, for they show no signs of attrition. Photographs of these are here reproduced. The one of the left side presents the grinding surface; that of the right, the inner face (pl. 3, figs. 2, 3).

The base of the crown of these premolars is oval and slightly wider behind than in front. The tooth of the left side is 28 mm. long and 20 mm. wide. The crown consists of two parts, the anterior of which, occupying seven-tenths of the length, forms a transverse crest rising 18 mm. from the base of the crown; the posterior part presents a low crest of two conules. The two parts are separated by a very distinct transverse valley. The inner face of the crown slopes away from the summits of the crests more slowly than the outer face. The anterior crest is composed of two closely appressed cones, the inner of which is the larger, although the two are of the same height. This inner cone consists of three conules, one in front of and one behind the principal conule. The hindmost forms a broad ridge which descends into the transverse valley, partially blocking it. In front, at the base of the anterior crest, is a small but distinct fold of enamel forming a talon. There is no trace of a cingulum on the sides of the crown. The hinder portion of the crown, occupying three-tenths of the length, presents a crest consisting of two low conules well separated. The inner of these is the larger. Applied rather closely to the rear of this is a smaller conule, whose hinder border merges into a sharp minutely tuberculated ridge. The conule and the ridge form a sort of talon at the rear of

[10] Proc. Biol. Soc. Washington, vol. 27, pp. 1–20.

the crown. The tooth of the right side is very similar to the left one, but it is slightly smaller, the length being 26 mm., the width 19 mm.

The roots of these teeth had evidently attained considerable size but both are broken off where they joined the crowns. In the base of each crown is a pulp cavity 11 mm. long and 6 mm. wide; and this was continued into the root. The walls of the root were from 3 to 5 mm. thick. There appears to have been one fang in front and a larger one behind. The fourth premolar, if there was one, is not in the collection. It will be further mentioned under the description of the fourth milk molar. A fourth premolar was present in *Gomphotherium leptodon* (*Mastodon angustidens*).

These teeth have the narrow oval form of the upper second premolar described by Schlesinger [11] but this is only 22 mm. long and 15.7 mm. wide. On the other hand, the Navasota teeth are considerably shorter, and relatively much narrower than the upper third premolar described by Schlesinger;[12] and the structure is different. Schlesinger gives the length as 39.4 mm., the width as 29 mm. It is evident, however, that the Navasota animal was smaller than the one in Schlesinger's hands, and the lower premolars are likely to be narrower than the upper ones.

The Navasota teeth differ from both the second and the third premolars described by Schlesinger in having the two crests more sharply separated by the transverse valley. Were it not that these premolars have been found in place in the jaw (Schlesinger, as cited) one might conclude that the left one belonged on the right side and *vice versa*. The Navasota teeth appear to agree in structure with the lower third premolar (designated as the first) of *Gomphotherium leptodon* described and figured by Lartet in 1859.[13] This appears, however, to have had a cingulum on the outer face.

3. Description of the milk molars and true molars

In the collection are the lower third milk molars, right and left. The one of the left side is the most nearly complete, the crown being wholly uninjured, but most of the hinder root and a part of the front root are broken off. In the one of the right side the front root is gone and with it a part of the first crest. The crown consists of three crests and front and rear talons. The crests are directed across the crown obliquely outward and backward. The crown of the left tooth is 60 mm. long, 28 mm. wide at the first crest, and 35 mm. at the third (pl. 4, figs. 1, 2). On the inner side the second crest is 23 mm. high. The summits of the cones of all

[11] Denkschr. Naturh. Staatsmus., Vienna, vol. 1, p. 14, pl. 2, fig. 3.

[12] Idem, same page and plate, fig. 4.

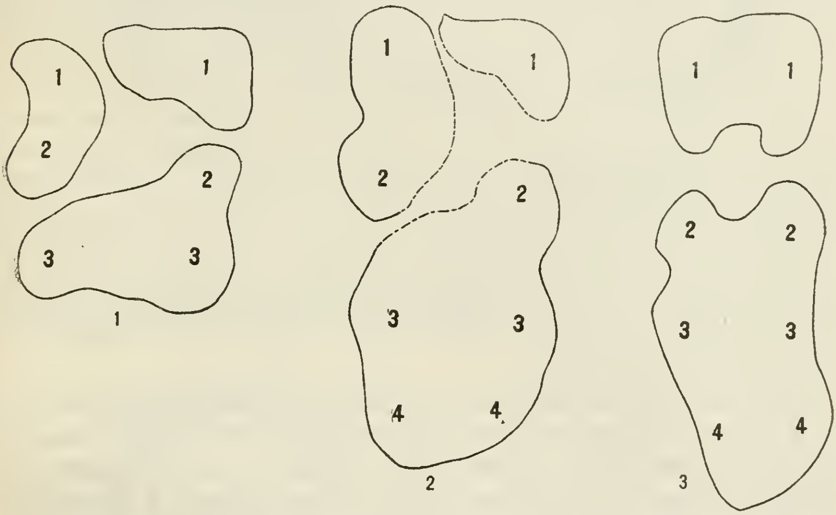
[13] Bull. Soc. Geol. France, ser. 2, vol. 16, p. 491, pl. 14, fig. 2, *B*.

the crests are slightly worn, the dentine being exposed on the outer ends of the first and second crests. The first valley is widely open, the buttress on the outer half of the crests being feebly developed. The second valley is partially blocked by the meeting of the buttress descending on the rear of the second crest and that on the front of the third. There is also a buttress on the front of the outer half of the third crest. At the front end of the crown is a distinct talon, but it is not prolonged into a cingulum on the sides. At the rear is a more considerable talon bearing four tubercles. On the front end of the crown is a polished area 15 mm. wide, where the tooth pressed against the hindmost milk molar. No pressure area is seen on the hinder end. The root consists of two fangs (pl. 4, fig. 2) the anterior of which supported the first crest; the second, the other two crests. Near its base the hinder root is 28 mm. wide. In the space between the front and the rear fangs of the right tooth is a fragment of bone 18 mm. high, 20 mm. fore and aft, and 17 mm. from side to side. If there was below this a fourth premolar, its summit must have lain at least 18 mm. below the crown of the milk molar or well at one side of the nodule of bone.

The upper right second molar presents a nearly perfect crown, lacking only a fragment of enamel on the outer cone of the second crest. Evidently this was splintered off during the life of the animal. The roots are broken off near their bases. The crown is well worn on the first and the second crests, only moderately so on the third (pl. 3, fig. 4). The length is 106 mm.; the width at all of the crests is 66 mm. On the inner ends both the first and the second valleys are obstructed by the strong buttresses of the rear and of the front of the inner cones. The wear of the main cones and the buttresses produces trefoils. There are mere traces of inner buttresses and there are no subsidiary cusps or conules produced in the valleys. There is present, on the inner face of the crown, a heavy tuberculated cingulum, which is carried around both the front and rear ends of the crown. On the outer face are hardly any traces of this cingulum. There are large polished pressure areas on both ends of the crown, that on the hinder fitting accurately against the third molar. There is in patches a thin layer of cement. The roots are disposed as is usual in the mastodons (text–fig. 1). One fang supports the outer end of the first crest; an inner fang supports the inner ends of the first and second crests; while a third supports the inner end of the third crest and the outer ends of the second and third.

The crown of the upper third molar lacks no part (pl. 3, fig. 5), but the roots are broken off near their bases. The crown is 136 mm. long and 73 mm. wide at the front crest. The height of the outer cone of the second crest is 50 mm., measured from the base of the crown. Only the summits of the cones of the first crest are worn, and these slightly. Evidently the tooth abutted against the second

molar just described. The anterior buttress of the first inner cone passes downward and outward in a broad ridge to join the well-developed front cingulum. Buttresses from the confronting faces of the first, second, and third crests join and close the first and second valleys. The third valley is rather open, there being on the hinder face of the third inner cone only a sharp ridge. The other buttresses are composed of conules more or less free at their summits. On a proper amount of attrition trefoils would be produced at the inner ends of the first, second, and third crests. No buttresses are present on the outer cones, but there is on the hinder face of the third one a tubercle which one may suppose might in some descendant have developed into a buttress. The rear of the tooth is a low mass of conules which represent an incipient crest fused with a talon.



FIGS. 1–3.—GOMPHOTHERIUM CIMARRONIS. ×.5. DIAGRAMS TO SHOW POSITION OF THE FANGS OF THE ROOTS. VIEWED WITH CROWN DIRECTED DOWNWARD. THE NUMERALS INDICATE THE CRESTS SUPPORTED. 1, UPPER RIGHT SECOND MOLAR; 2, UPPER RIGHT THIRD MOLAR; 3, LOWER LEFT THIRD MOLAR

At the inner end are two stout conules, the anterior of which appears to represent the principal cone of a crest. The still larger conule behind this may belong to the talon. Between these two conules and the outer one is a row of three smaller ones. The talon is completed by two small conules one of which is applied against the large hinder and inner conule. The second outer cone shows at its summit a row of five conules; while the third displays only two. Each inner cone has a conule applied to its face next the median fissure. The cingulum in front is continued on the inner face as a well developed tuberculated and beaded ridge. It ceases behind the third transverse valley. In the valleys there is a considerable accumulation of cement, and a coat of this covers the bases of the roots. The roots are disposed as in the second molar described above (text-fig. 2), but the hinder root is larger than in the second molar.

The crown of the lower left hindmost molar (pl. 3, fig. 6) is in perfect condition. The roots, except their bases, are missing, a result apparently, of rude methods of collecting. The left, or outer, border of the crown is nearly straight, the inner border is slightly convex. The wear from mastication has affected the summits of the three crests. We may judge therefrom that this tooth did not belong to the same individual as did the upper third molar.

The length of the crown is 136 mm.; the width at the first crest, 62 mm.; at the third, 64 mm. The height of the second inner cone, slightly worn, is 45 mm. There may be said to be four crests, the fourth not yet separated from the talon. The buttresses applied to the front and rear faces of the outer cones join and block the valleys. On sufficient wear the cones and buttressing conules would produce trefoils with large basal lobes. The buttress on the hinder face of the third outer cone is composed of three or four conules. The imperfect fourth crest and the talon fused therewith form a rosette inclosing a pit. The crest portion is composed of an outer and an inner pair of conules, the pairs being separated by the thin fissure which traverses the crown from front to rear. In each pair the conule next the fissure is the smaller. In the outer pair the smaller conule is situated in front of the larger one and corresponds to a buttress. The talon portion is composed of a curved row of six closely appressed conules. There is no cingulum except the usual ridge in front. A large tubercle at the outer end of the valleys may represent the cingulum.

The inner cone of each crest is divided by a thin fissure into two parts, a small inner one and a larger outer. Each outer cone is divided by an oblique fissure which cuts off a conule forming the anterior buttress. A small amount of cement appears in the valleys and in thin patches elsewhere. The roots (text-fig. 3) consisted of an anterior fang which supported the anterior crest and a larger one which sustained the remainder of the crown.

4. Description of the tusks, upper and lower

The fragments of upper tusks represent at least four individuals. One is indicated by only one fragment about 95 mm. long, but its diameters exceed all of the others, its greater axis being 66 mm., its smaller 49 mm. A very young individual is represented by two lower tusks. Four fragments of upper tusks contain the pulp cavity. These appear to have belonged to two individuals. Of one of these there are three pieces. The most important tusk consisted of several fragments, one of which is missing. The pulp cavity is 100 mm. deep, but it is estimated that it was originally at least 140 mm. deep. The fragment which connects with the one just mentioned is 96 mm. long, and it came down near the end of the

premaxilla (text-fig. 4). The base of this tusk is at the left end of the figure. There is accurate contact between the two pieces on the side not seen. The diameter of the tusk at the proximal end is 60 mm., and 50 mm. at the end of the premaxilla. The cross-section (text-fig. 5) is somewhat pear-shaped. The enamel band is

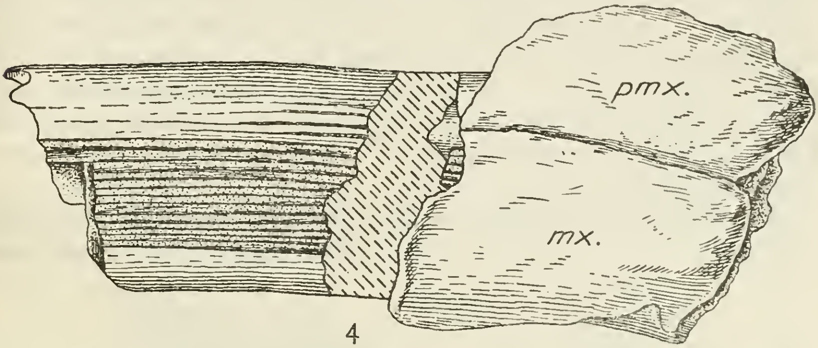


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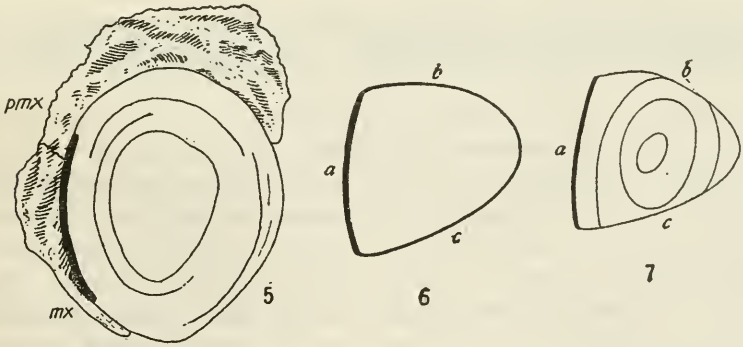
FIG. 4.—GOMPHOTHERIUM CIMARRONIS. VIEW OF BASE OF UPPER RIGHT TUSK, SEEN FROM OUTSIDE. *mx.*, FRAGMENT OF MAXILLA. *pmx.*, FRAGMENT OF PREMAXILLA. ×.5

shown by the thick black line. Five fragments fitting accurately and cemented together are believed to belong to this same tusk. At its proximal end the greater diameter is 56 mm., the lesser 47 mm. Inasmuch as the diameter at the distal end of the premaxilla is only

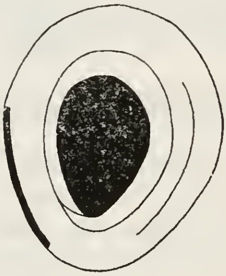


FIGS. 5–7.—GOMPHOTHERIUM CIMARRONIS. 5, CROSS SECTION OF TUSK OF FIGURE 4, WHERE IT EMERGES FROM THE SKULL. SEEN LOOKING TOWARD THE SKULL. ENAMEL BAND BLACK. ×.75. 6, CROSS SECTION OF TUSK 150 MM. ABOVE DISTAL EXTREMITY. SEEN LOOKING TOWARD SKULL. ×.6. *a.* ENAMEL BAND; *b.* UPPER SURFACE; *c.* LOWER SURFACE. 7, CROSS SECTION OF TUSK TAKEN 100 MM. ABOVE DISTAL END. SEEN LOOKING TOWARD SKULL. ×.6. *a, b, c.* AS IN FIGURE 6

4 mm. more than this, the length of the piece missing can not be great, but it can hardly be determined. This distal portion (pl. 4, fig. 3) is curved outward and slightly downward. The band of enamel is on the concave side. This band becomes reduced in width at the proximal end as age advances. On the fragments bearing the pulp

cavity the width of the band varies from 24 to 30 mm. On the long fragment figured the width is 40 mm. Toward the distal end the form of the section varies. This happens because of the wear to which the ivory was subjected. On the whole inner face of the long fragment the ivory is worn, the amount increasing toward the distal end. This was produced probably by the friction of the proboscis. A cross-section 100 mm. from the distal end is shown by text-figure 6; another, 150 mm. from tip, by text-figure 7. The lower border of this area of attrition comes down to the lower edge of the enamel band, and thus was formed a sharp cutting instrument for a distance of nearly 250 mm. The distal end of the tusk is likewise rounded off and polished.

It is evident that the tusk was subjected to rougher usage than friction by the proboscis. It will be seen (pl. 4, fig. 3) that along



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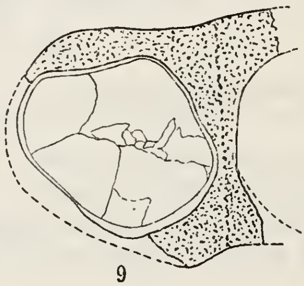

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Figs. 8–9.—Gomphotherium cimarronis. 8, Cross section of an upper tusk taken a short distance below the proximal end. The black center represents the pulp cavity; the black band, the enamel. ×.6. 9, Cross section of distal end of lower jaw, showing right and left rami and the right tusk. ×.57

the upper edge of the enamel band and near the distal end are four notches. Here the enamel had evidently had pieces broken out of it as though it were glass. This had been done during the life of the mastodon, for the broken edges are rounded off and from each notch there runs a broad shallow groove in the ivory. These had probably been produced by play of roots or vines or branches of trees. Text-figure 8 represents a cross-section of the upper left tusk near its base. This tusk probably belonged to the same individual as did the one just described.

In the collection is a portion of the distal end of the lower jaw containing a fragment 125 mm. long, of the right lower tusk. Text-figure 9 represents a cross-section of this fragment of tusk and bone; and figure 4 of plate 4 is a reproduction of a photograph of the broken end of the tusk. It will be seen that the two tusks were, as in *Gomphotherium productum*, separated by a bony septum. At the rear of the fragment this septum is 7 mm. thick. It will be observed

also that the cross-section of the tusk is different from that of *G. productum.* It is quite different, too, from that of *G. angustidens*, as figured by Schlesinger[14] It resembles more closely the section of lower tusk figured by Cope in his descriptoin of *G. productum*,[15] but is yet different. The long diameter is 49 mm., the shorter one 37 mm. There is a faint groove or channel on the lower side and a similarly faint one on each side of the prominent upper ridge.

In the collection are parts of two tusks of a young specimen supposed to belong to the same species as did the adult remains. The larger piece, now 90 mm., must have been still longer, since no pulp cavity is present. The cross-section is broadly oval, without any ridge or channel. As in other cases, the narrow end of the oval is taken to be away from the midline of the jaw. The rear part of the fragment is yet covered with the thin coat of cement. Where this is removed the surface is traversed by narrow parallel ridges and grooves. At the distal end of these tusks are distinct evidences that they were useful instruments. Figure 5 of plate 4 shows these fragments of tusks as seen from above and of the natural size. It will be noted that each has a large worn and polished surface 35 mm. long. On the underside (fig. 6) is another polished surface not quite so large. On the outer border the two surfaces round into each other. On the face next to its fellow the tusk of the right side has a flat worn surface 18 mm. long, not seen in the figure, as if it had worked in contact with the other one, but this other shows no indications of any such friction. This worn surface is crossed by about 14 grooves. The ridges between these are possibly the outcropping edges of the layers of ivory, but this is uncertain.

5. Identity of the Navasota mastodon

The writer refers the Navasota remains here described to Cope's form which he named *Tetrabelodon serridens cimarronis*.[16] It is therefore to be known as *Gomphotherium cimarronis* (Cope). According to Osborn,[17] this was found in the Upper Miocene near Clarendon, Texas. The type is a tooth said by Cope to be the left lower last molar. To the writer the tooth has greatly the appearance of being the left upper tooth. Possibly the arrangement of the anterior fangs of the root might decide the matter. The fact that there is in the type a cingulum called external appears to show that the tooth is an upper one.[18] The upper hinder

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[14] Denkschr. Naturh. Staatsmus., Vienna, vol. 1, pl. 1, fig. 5.
[15] Wheeler's Surv., vol. 4, pl. 71, fig. 8.
[16] Vert. Palaeont. Llano Estacado, 1893, pp. 18–20, pl. 3, figs. 1, 2.
[17] Amer. Mus. Novitates, No. 1, p. 8.
[18] Cope, Wheeler's Surv., vol. 4, p. 19.

molar of the Navasota mastodon is only 6 mm. shorter and 7 mm. narrower than Cope's type. The principal known difference between Cope's *Mastodon serridens* and the form *cimarronis* is that the former is much larger. The type of *serridens* was taken to be a first or second molar whose length is 130 mm. The length of the upper second molar of the Navasota mastodon is only 105 mm. It does not show the original condition of the grinding surface; but the hindmost molar does this; and the cross-crests and the buttresses present nearly the same tuberculated condition as does the type of Cope's *Mastodon serridens.* The differences in the tuberculation of the two forms as pointed out by Cope are probably of minor importance.

Schlesinger[19] describes a form of mastodon to which he gave the name *Mastodon angustidens subtapiroidea.* This resembles in many respects the *G. cimarronis*, so far at least as regards the molars; but the latter species appears to be more advanced. If they should be shown to be identical forms, *cimarronis* would supersede *subtapiroideus. Gomphotherium cimarronis* differs from *G. productum* in that the teeth are less hypsodont.

EXPLANATION OF PLATES

Plate 1

Anancus brazosius

View of occlusal surface of the right lower third molar. ×.83. No. 41652. British Museum of Natural History.

Plate 2

Anancus brazosius

Fig. 1. Same tooth as that figured on Plate 1. ×.47.
2. Mandible and third molar from Cameron, seen from lingual side. ×.21.

Plate 3

Anancus brazosius

Fig. 1. Same mandible and molar as that of Figure 2 of Plate 2, seen from above. ×.46.

Gomphotherium cimarronis

Figs. 2, 3. Lower right and left third premolars. ×.96.
2. Left seen from above.
3. Right seen from the lingual side.
4. Upper right second molar. ×.5. View of occlusal surface.
5. Upper right third molar. ×.5. Shows occlusal surface.
6. Lower left third molar. ×.5. Shows occlusal surface.

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[19] Denkschr. Naturh. Staatsmus., Vienna, vol. 1, pp. 30–38, pl. 7, fig. 3.

PLATE 4

Gomphotherium cimarronis

FIG. 1. Lower left third milk molar. ×.94. Shows occlusal surface.
2. Same milk molar. ×.51. View of left, or outer, face.
3. Part of upper tusk of right side. ×.17. View of outer and upper surfaces.
4. Cross-section of a lower left tusk. ×.91. Seen from front.
5. Right and left lower tusks of young individual. ×1. Seen from above.
6. Left tusk of Figure 5. Seen from below.

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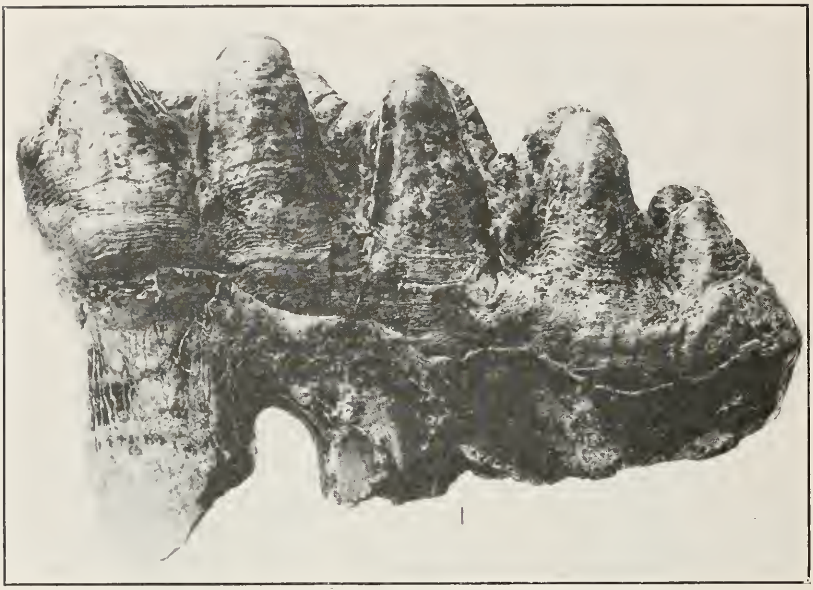
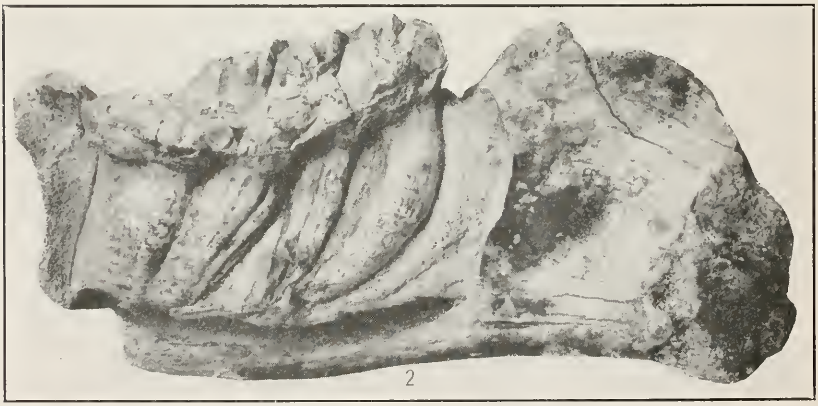
LOWER MOLAR OF ANANCUS BRAZOSIUS

FOR EXPLANATION OF PLATE SEE PAGE 14

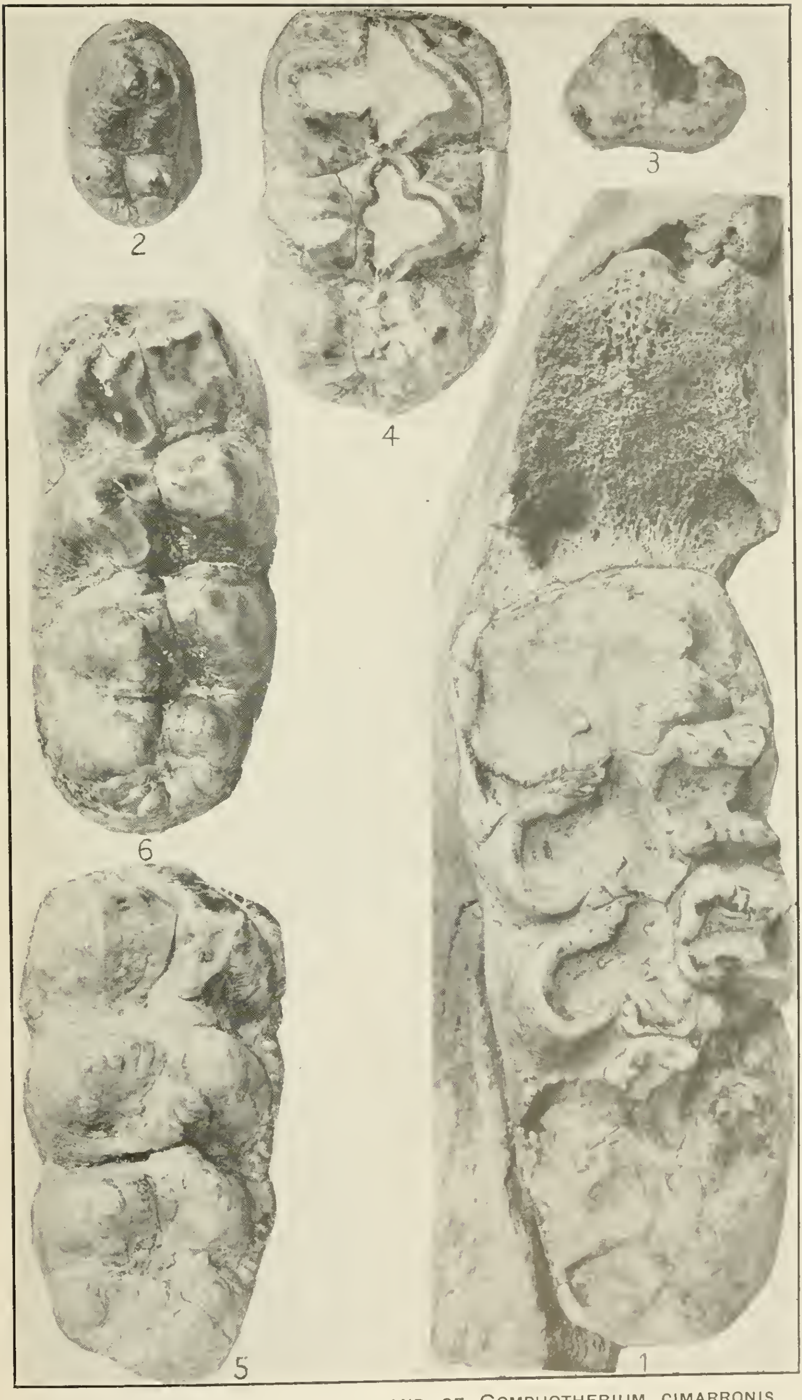


LOWER MOLAR OF ANANCUS BRAZOSIUS



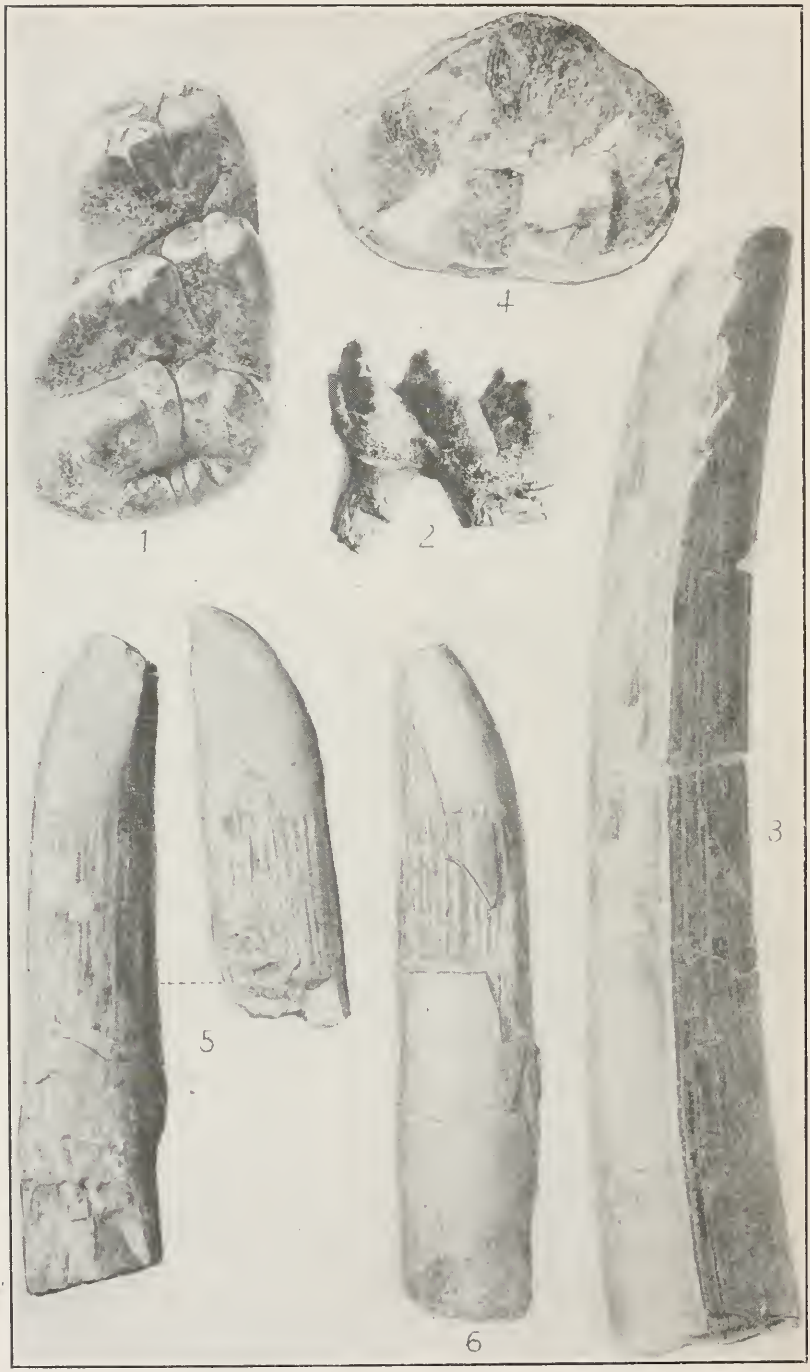
LOWER JAW OF ANANCUS BRAZOSIUS

FOR EXPLANATION OF PLATE SEE PAGE 14



TEETH OF ANANCUS BRAZOSIUS AND OF GOMPHOTHERIUM CIMARRONIS

FOR EXPLANATION OF PLATE SEE PAGE 14



TEETH AND TUSKS OF GOMPHOTHERIUM CIMARRONIS

FOR EXPLANATION OF PLATE SEE PAGE 15